Prepared for:

U.S. ARMY CORPS OF ENGINEERS RAMS PROGRAM
AND
BUREAU OF LAND MANAGEMENT
Carson City, Nevada Field Office

FINAL WORK PLAN

PERRY CANYON SITE INVESTIGATION
USACE CONTRACT NO. DACW45-03-D-0001

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Prepared by:

MWH
1475 Pine Grove Road, Suite 109
P.O. Box 774018
Steamboat Springs, CO 80487
(970) 879-6260

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ACRONYMS

ABA	Acid-Base Accounting
AGP	Acid Generation Potential
ANP	Acid Neutralization Potential
ARD	Acid Rock Drainage
BLM	Bureau of Land Management
CCV	Continuing Calibration Verification
COCR	Chain-of-Custody Record
CRDL	Contractor-Required Detection Limits
CRQL	Contract-Required Quantitation Limits
DQO	Data Quality Objective
FSP	Field Sampling Plan
IDL	Instrument Detection Limits
LCS	Laboratory Control Sample
MDL	Method Detection Limits
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MWH	MWH Americas, Inc.
MWMP	Meteoric Water Mobility Procedure
NBMG	Nevada Bureau of Mines and Geology
PQL	Practical Quantitation Limits
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RAMS	Restoration of Abandoned Mine Sites
SOW	Scope of Work
SSHSP	Site Specific Health and Safety Plan
SOPs	Standard Operating Procedures
USACE	United States Army Corps of Engineers

EXECUTIVE SUMMARY

The Perry Canyon site is an area of historic abandoned mining in the Pyramid Mining District located in Washoe County, Nevada, approximately 30 miles north of Sparks, Nevada. The Crown Prince Mine and Jones-Kincaid Mine within Perry Canyon have been observed to discharge small volumes of low pH water with some high metals concentrations. Efflorescent mineral salts occurring near the mine adits have also been observed. Concern has been expressed about the site because water in Perry Canyon flows to Mullen Pass, and groundwater in Mullen Pass is used for domestic water supply. This Work Plan describes the site and presents the tasks that will be completed to characterize potential impacts resulting in historic mining activities. Funding for the project is being provided through the United States Army Corps of Engineers Restoration of Abandoned Mine Sites program.

The scope for this Work Plan is based on the revised scope of work presented in the June 27, 2003 Scope of Work for Site Characterization Study, Perry Canyon, Nevada. The objective of the proposed data collection is to provide information that can be used for describing mine facilities and associated environmental impacts and for evaluating potential reclamation alternatives. Tasks to be completed include water quality sampling (groundwater, springs/seeps and surface water), waste rock characterization, and efflorescent mineral characterization. This Work Plan describes each of these tasks and includes a Field Sampling Plan, which provides detailed information on sampling and analyses associated with each task, and a Quality Assurance Project Plan, which provides information on analytical procedures and quality control.

The Perry Canyon site is located within a small narrow canyon in the northern Pah Rah Range with adjacent ridge tops 500 to 1,000 feet above the canyon floor. The geology of the canyon area consists of sequences of volcanic tuffs. A small ephemeral creek flows through the canyon with springs and mine water seeps located at several locations along the creek. Water flowing from the springs typically infiltrates back into the alluvium within a short distance during dry conditions. Mining in the district began in the mid- to late-1800s along steeply-dipping northwesterly-oriented veins with silver as the primary commodity, but gold and copper were also produced. The Jones-Kincaid Mine was developed in the 1870s and consists of an approximately 1,000 foot-long adit, 500 foot-deep shaft, drifts and other minor workings. The adit portal is collapsed, but the shaft remains open at the surface. A history and description of the Crown Prince Mine is not available, but this mine has at least a single adit that is currently partially open.

Limited sampling of the adit discharge and two (of four) groundwater monitoring wells installed by the Bureau of Land Management has been conducted. The results of this sampling indicated that the Crown Prince Mine water has a low pH (2.4) with elevated concentrations of sulfate and several metals including, but not limited to, aluminum, arsenic, cadmium, copper, iron, manganese, and zinc. Comparison of analytical data from the upgradient and downgradient wells suggests only minor, if any, impacts to groundwater as a result of the historical mining activities. The activities presented in this Work Plan will help confirm or refute this observation.

The sampling tasks identified in this Work Plan will provide additional site characterization with samples collected quarterly over one annual period. This program will include sampling and analysis of all four groundwater monitoring wells installed in the canyon for Nevada Profile II parameters and field parameters including pH, conductivity, temperature, dissolved oxygen, and turbidity. In addition, the discharges from the Crown Prince Mine and Jones-Kincaid Mine adits will be collected and analyzed for the same parameters, and flows will be gauged. A stream station between the Crown Prince and Jones-Kincaid waste rock piles will also be sampled and gauged quarterly, if flowing. A natural spring upstream of the mines will also be sampled during one of the quarterly events. During the first quarterly event, weather permitting, one composite sample of waste rock will be collected from each of the Crown Prince and Jones-Kincaid waste rock dumps (adit dumps). These samples will be analyzed for acid-base accounting parameters and leachate composition using the Nevada meteoric water mobility procedure (i.e., MWMP) and the Nevada Profile II parameter list. Dimensions of the piles will also be measured using a handheld GPS unit. The final component of the characterization plan will be the collection and analysis of the efflorescent minerals that have formed near the Crown Prince and Jones-Kincaid adits. One composite sample will be collected from each location and analyzed for a suite of total metals.

The current schedule for implementing this Work Plan calls for initiation of the quarterly sampling in early September 2003, after review and approval of this Work Plan. Three additional quarterly events are scheduled for December 2003, March 2004 and June 2004. A draft and final report will be issued with the final report submission planned for September 2004.

1.0 INTRODUCTION

This introduction presents general project information, program funding, scope and objectives of the project, and the organization of this Work Plan. Generally, this Work Plan discusses the project and site background, physical setting of the site, project characterization tasks to be completed, and the project schedule.

1.1 GENERAL PROJECT INTRODUCTION

The Perry Canyon site (the site) is an area of historic abandoned mining in the Pyramid Mining District located in Washoe County, Nevada, approximately 30 miles north of Sparks, Nevada within the Basin and Range physiographic province. The site is located south of Mullen Pass in the Pah Rah Mountains, which run along the southwest shore of Pyramid Lake (see Figure 1-1, *General Site Location Map*). The site is located at elevations ranging from approximately 4,600 to 5,900 feet above mean sea level (MSL). Access to the site is via Nevada State Highway 445 and a four-wheel drive road that runs south from Mullen Pass up Perry Canyon. The nearest town is Sutcliffe, Nevada with a population of 281 (2000 Census). Sutcliffe is located about 8 road miles north of site. The site is on public lands administered by the Bureau of Land Management (BLM) with some patented mining claims.

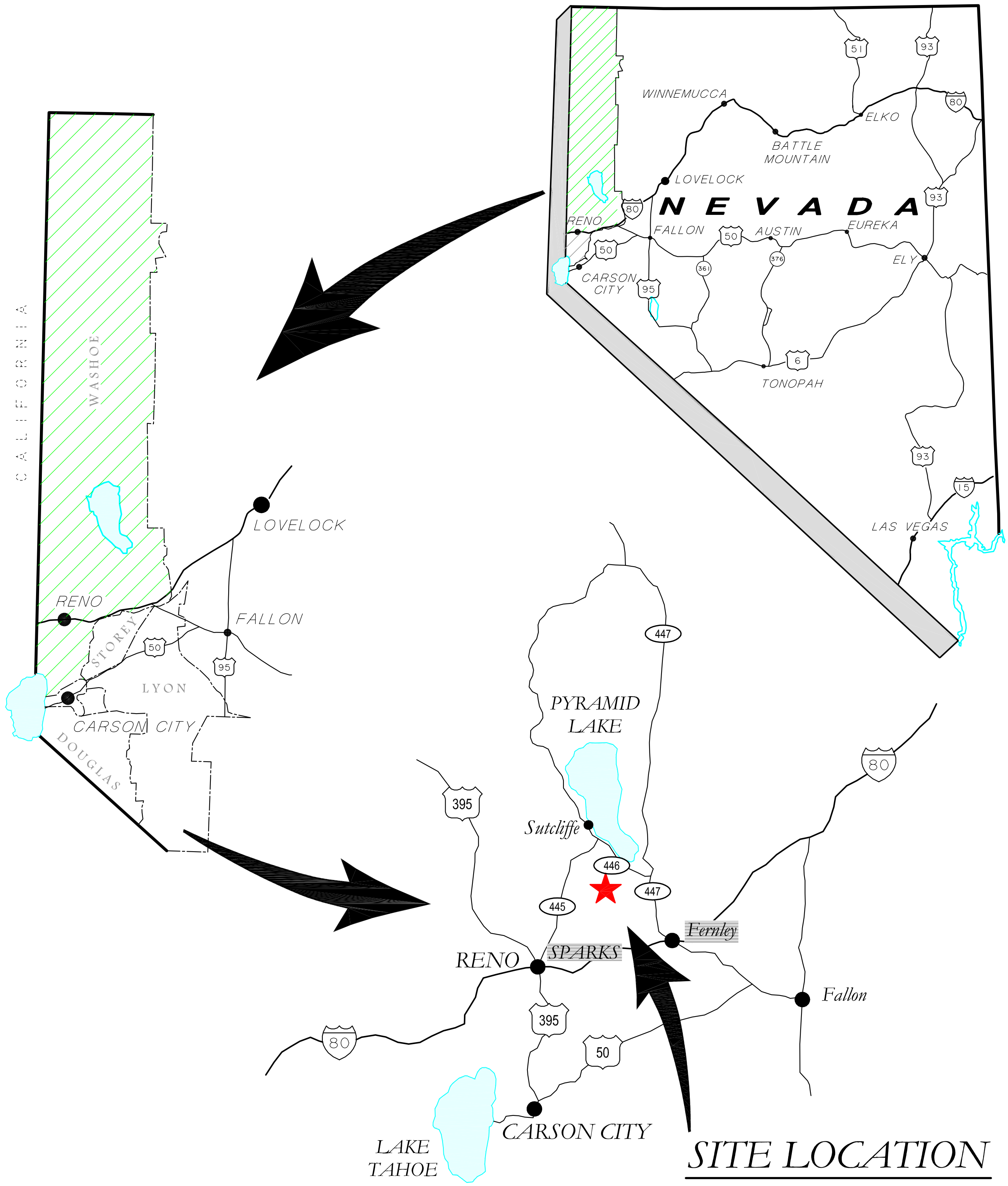
The site consists of several small abandoned mines that were mined in the late 1800's primarily for silver and copper. At least six mine openings are identified in the immediate area on U.S. Geological Survey maps along with numerous mineral prospect holes. The Nevada Bureau of Mines and Geology (NBMG) and the BLM have identified two mines, the Crown Prince and Jones-Kincaid Mines, as being of particular concern. The locations of these mines are shown on Figure 1-2, *Site Layout*. Mine features include the Jones-Kincaid shaft, the Jones-Kincaid and Crown Prince adits, and associated waste rock piles. Both the Crown Prince and Jones-Kincaid Mines have been identified as producing acid rock drainage (ARD) with a pH as low as 2.4 and elevated concentrations of several metals. These mines are located along the creek that flows through Perry Canyon. The creek in Perry Canyon flows north to Mullen Creek in Mullen Pass, which flows to Pyramid Lake. The Mullen Creek valley is the source of domestic groundwater supply for the town of Sutcliffe and Pyramid Lake Tribal Land. Concerns have been expressed that water originating from Perry Canyon may be contaminating the water supply.

This Work Plan presents data collection activities that will be conducted to help characterize the site. The work conducted at the site will focus on the characterization of surface water, groundwater, waste rock, and efflorescent salts that have been observed at the site.

1.2 RESTORATION OF ABANDONED MINE SITES (RAMS) PROGRAM

The United States Army Corps of Engineers (USACE) established the Restoration of Abandoned Mine Sites (RAMS) program in 1998 to assist in restoration and remediation of non-coal abandoned mines. The program addresses environmental and water quality problems caused by drainage and related activities from abandoned, inactive non-coal mines. The program supports activities and priorities of Federal, State, Tribe and nonprofit entities.

The RAMS program is managed through three regional business centers, Western, Mid-continent, and Appalachian, each of which is made up of multiple Corps Districts. The current work for the Perry Canyon site is located within the Sacramento District boundary but is being coordinated by the Omaha District of the USACE and the Carson City Field Office of the BLM. The RAMS program is funded by federal appropriations through the Corps Civil Works.



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U.S. Army Corps of Engineers

MWH

PROJECT No.: 1003797.011801

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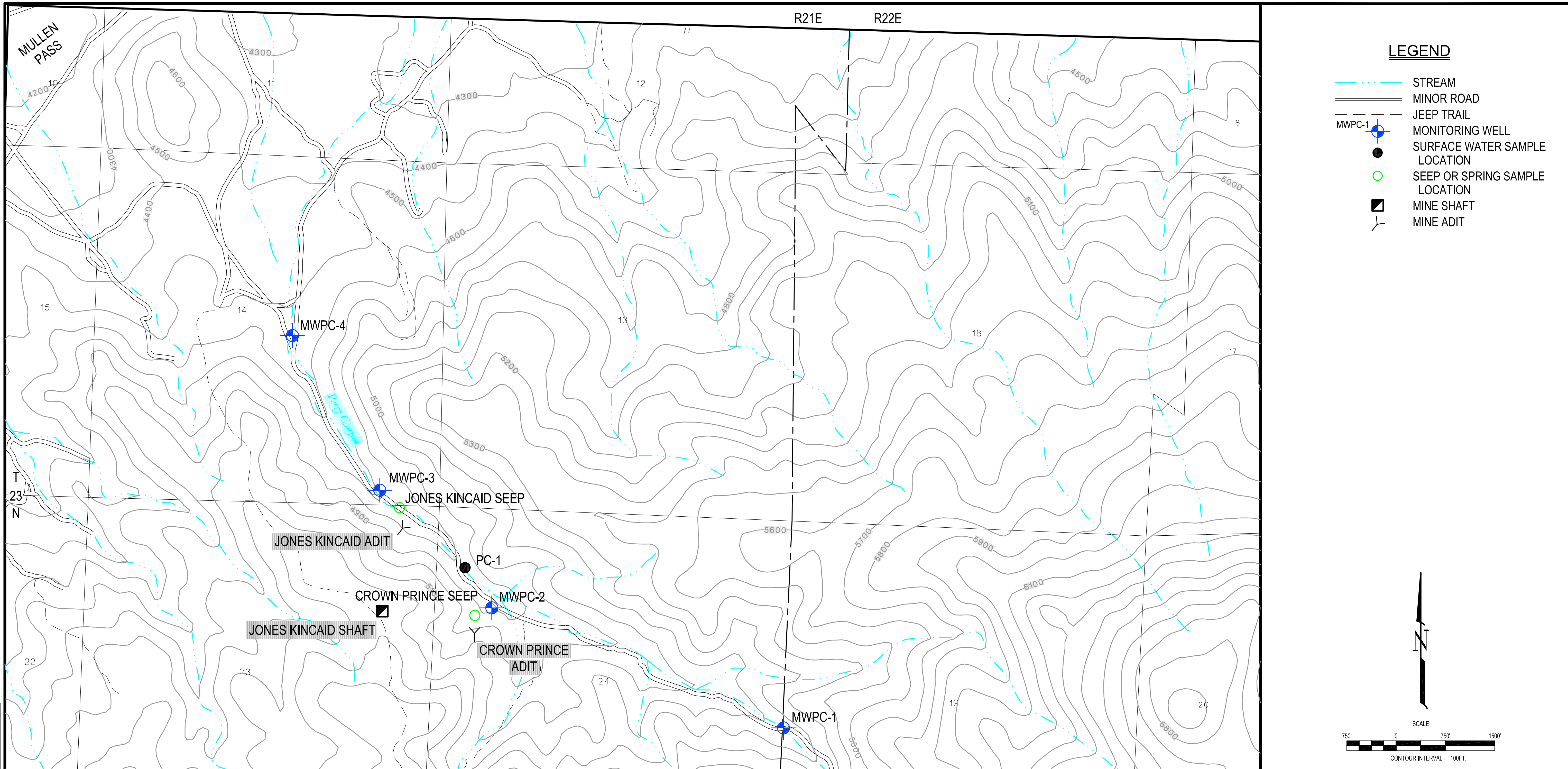
GENERAL SITE LOCATION MAP



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U.S. ARMY

CORPS OF ENGINEERS

PROJECT:
PERRY CANYON SITE CHARACTERIZATION

DRAWING TITLE:
SITE LAYOUT

MWH

Sheet 1 Of 1 Sheets

SCALE: As Shown

DRAWING No. 1-2

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1.3 PROJECT SCOPE AND OBJECTIVES

The scope for this Work Plan is based on the revised scope of work (SOW) presented in the June 27, 2003, SOW for Site Characterization Study, Perry Canyon, Nevada presented to MWH Americas, Inc. (MWH) by the USACE. The objective of the proposed data collection is to provide information that can be used for describing mine facilities and associated environmental impacts, and evaluating reclamation alternatives. This scope includes the following tasks:

- Water Quality Sampling (Groundwater, Springs/Seeps and Surface Water)
- Waste Rock Characterization
- Mineral Salts Characterization

Each of these tasks is discussed in more detail in the following sections of the Work Plan. The Field Sampling Plan (FSP) provides detailed information on sampling and analyses associated with each task and the Quality Assurance Project Plan (QAPP) provides information on analytical procedures and quality control.

1.4 WORK PLAN ORGANIZATION

This Work Plan is divided into six sections and four appendices. This first section provides an introduction to the Work Plan, the project scope and objectives. Background information for the site is provided in Section 2.0. Site conditions and a description of mine facilities are presented in Section 3.0, and Section 4.0 provides a description of each task contained within the Work Plan. The project schedule is provided in Section 5.0, and Section 6.0 lists references cited in this document.

Supporting materials are provided in appendices. Appendix A presents the FSP for the activities presented in the Work Plan. The QAPP is presented in Appendix B. A Site-Specific Health and Safety Plan (SSHSP) is provided in Appendix C. Standard Operating Procedures (SOPs) are provided in Appendix D.

2.0 PROJECT BACKGROUND

This section provides background information for the site including a general site description and a summary of past activities.

2.1 GENERAL SITE DESCRIPTION

The Perry Canyon site is located within a small narrow canyon in the Pah Rah Range with adjacent ridge tops 500 to 1,000 feet above the canyon floor. A small ephemeral creek is located in the canyon with springs and mine water seeps located at several locations along the creek. The water flowing from the springs typically infiltrates back into the alluvium within a short distance during dry conditions. Perry Canyon drains toward the northwest to Mullen Creek, in Mullen Pass and into Pyramid Lake. Although perennial flow is not present in Perry Canyon, scattered riparian willows, wild roses and cottonwood trees are present in the drainage. Over the majority of the site, sagebrush and juniper dominate the vegetation.

The primary focus of the project is the Crown Prince Mine and Jones-Kincaid Mine located in Perry Canyon. The mines are part of the Pyramid Mining District and are on public lands administered by the BLM and on patented mining claims. Each mine contains a single adit near the bottom of the canyon along with an associated waste rock dump. The Jones-Kincaid Mine also has a shaft and associated waste rock dump that is located approximately 500 feet above the adit on the ridge top to the south of the adit (see Figure 1-2, *Site Layout*). Both mine adits discharge small flows of ARD with elevated concentrations of some metals. While direct impacts associated with the discharges have been observed (efflorescent mineral and minor vegetation impacts), impact to groundwater in Mullen Pass is the primary concern associated with the site due to the presence of domestic water supply wells in that area.

2.2 SITE HISTORY

The majority of mining in the Pyramid District occurred between 1881 and 1912, although the first discovery occurred as early as 1863 (Garside, et al., 2000). The Jones-Kincaid Mine in Perry Canyon was one of the earliest producers having been mined in the 1870s (Bonham and Papke, 1969). Information on the Crown Prince Mine is generally lacking, and information relating to its development history has not been located. The last recorded production for the Pyramid District was in 1952 (Bonham and Papke, 1969). Exploration sampling and drilling has occurred in the Perry Canyon area periodically between early 1980 and 1992 (Garside, et al., 2000).

Silver was the primary commodity extracted with 2,722 ounces reported; although, actual production is likely greater because production records are not available for all years. A few ounces of gold production was also reported (Bonham and Papke, 1969). Copper mineralization is extensive in the veins mined and was produced, but it is not indicated as to how much this production added to the district record.

2.3 PREVIOUS ACTIVITIES

As indicated in the site history, mining in Perry Canyon largely occurred before 1900. Livestock grazing and some later mining and exploration has occurred; however the most significant activity to impact the canyon was the early mining. Evaluations of the environmental impacts associated with the mining appear to have begun about 1995, as described below.

The seepage from the Jones-Kincaid Mine was sampled in 1995 as part of an assessment of abandoned mines in Nevada (Price, et al., 1995). The data from this sample analysis are included in Table 2.1, *Historic Water Quality Analyses in Perry Canyon*.

TABLE 2.1
HISTORIC WATER QUALITY ANALYSES IN PERRY CANYON

Type	Adit Discharge		Groundwater (Monitoring Well)	
Location	Crown Prince Adit		Canyon Mouth	Background
Sample ID	WA-95 (1)	CP-1 (2)	MWPC-4 (2)	MWPC-1 (2)
Date	1995	11/21/02	11/21/02	11/21/02
Flow (L/min)	1.5	nm	na	na
Field pH (s.u.)	2.4	2.4	7.6	7.5
Field Conductivity (µS/cm)	nm	6,500	1,300	500
Alkalinity	< 10	< 1	40	77
Total Dissolved Solids	--	10,000	1,200	410
Nitrate as N	< 0.5	< 0.5	0.39	< 0.05
Total Phosphorus	--	6.3	0.29	0.34
Calcium	234	360	170	43
Magnesium	174	260	81	23
Potassium	6	< 1	4.1	4.9
Sodium	47	65	74	49
Chloride	3.0	15	17	14
Fluoride	--	< 1	0.63	0.33
Sulfate	4,620	7,100	800	190
Antimony	--	0.17	< 0.002	< 0.002
Aluminum	--	250	0.32	< 0.05
Arsenic	16.0	17	< 0.002	0.003
Barium	--	< 0.005	0.024	0.006
Beryllium	--	0.013	< 0.002	< 0.002
Bismuth	--	0.1	< 0.05	0.05
Boron	--	< 0.05	0.08	0.09
Cadmium	0.9	0.36	< 0.002	< 0.002
Chromium	0.4	0.13	< 0.002	< 0.002
Gallium	--	0.5	< 0.1	< 0.1
Silver	--	< 0.005	< 0.002	< 0.002
Cobalt	6	0.47	< 0.002	< 0.002
Copper	451	350	0.008	0.003
Iron	1,380	1,400	0.67	< 0.05
Lanthanum	--	< 0.05	< 0.05	< 0.05
Lead	3.1	0.010	0.002	< 0.002
Lithium	--	< 0.1	< 0.1	< 0.1
Manganese	19	20	0.016	0.037
Mercury	--	< 0.0002	< 0.0002	< 0.0002
Molybdenum	--	0.007	< 0.002	0.002
Nickel	--	0.42	0.01	0.003
Scandium	--	< 0.05	< 0.05	< 0.05
Selenium	--	0.021	< 0.002	< 0.002
Strontium	--	0.76	0.99	0.31
Thallium	--	< 0.0025	< 0.001	< 0.001
Titanium	--	< 0.05	< 0.05	< 0.05
Tin	--	< 0.05	< 0.05	< 0.05
Vanadium	--	0.33	< 0.002	< 0.002
Zinc	34	24	0.052	0.022

Notes:
Dissolved fraction analyzed in November 2002.
Units in mg/L unless otherwise noted.
(1) From Price (1995) – Crown Prince adit.
(2) Unpublished data provided by BLM.
nm not measured
na not applicable

Site visits by BLM and NBMG further documented the environmental concerns at the site, and four groundwater monitoring wells were installed by the BLM in the canyon between October 16 and 19, 2002. The well reports and boring logs for these wells are included in Appendix E, and the locations are shown on Figure 1-2. The purpose of these wells was to monitor the shallow alluvial water in the Canyon. The wells were positioned in an upgradient (background) position (MWPC-1), below the Crown Prince adit and waste rock dump (MWPC-2), below the Jones-Kincaid Mine and waste rock dump (MWPC-3), and in the mouth of the canyon (downgradient) (MWPC-4). All wells were screened within the first occurrence of groundwater. Wells MWPC-2 and MWPC-4 were screened within the surficial alluvial material. However, the thickness of the alluvium in the canyon varies and shallow groundwater first occurred in bedrock at two of the locations (MWPC-1 and MWPC-3).

The upgradient well (MWPC-1) and the furthest downgradient well (MWPC-4) were sampled by the BLM on November 21, 2002. These water quality data are provided in Table 2.1. The groundwater well data indicate that the water quality downgradient of the mines in the canyon is generally similar in pH and metals concentration to the upgradient groundwater. The pH of both groundwater samples was near neutral and only aluminum and iron are present in the downgradient well at concentrations five time the upgradient concentrations. Total dissolved solids are about three times higher in the downgradient well. Arsenic, which is of particular concern, was not detected in the downgradient well with a detection limit of 0.002 mg/L. Arsenic was detected in the upgradient well at 0.003 mg/L. Several of the major cations and anions are elevated in the downgradient well compared to the upgradient well. Most notably elevated are calcium, magnesium, sodium, and sulfate. This coupled with the higher iron and aluminum concentrations may be an indicator of the affects of the mining, or may be the result of the natural chemical evolution of the water moving down the canyon.

2.4 CURRENT SITE STATUS

No mining or processing activities are occurring at the site at this time. The area is open to public access, and appears an attractive area for target shooting. Some cattle grazing also occurs. The site is visited periodically by BLM and NBMG staff to monitor site conditions.

3.0 SITE DESCRIPTION

The physical conditions in Perry Canyon and associated with the Crown Prince and Jones-Kincaid Mines are described in this section. In general, sufficient information is available for the area to provide a basis for developing concepts as to the environmental processes acting at the site.

3.1 CLIMATE

The Perry Canyon climate is arid. The area receives an average of approximately 7.81 inches of rain per year, as measured at nearby Sutcliffe, Nevada for the period of 1967 to 2002 (WRCC, 2003; for location of Sutcliffe see Figure 1-1). Most precipitation occurs during the winter months with a maximum monthly average precipitation of 1.39 inches at Sutcliffe in January. The minimum monthly average of 0.19 inches occurs in July and August. An average annual pan evaporation of 62 inches measured at Fallon, Nevada, approximately 45 air miles to the east-southeast of the site (Shevenell, 1996). The maximum average monthly temperature of 88.7 ºF occurred in July, and the minimum of 29.2 ºF occurred in January (WRCC, 2003). Sutcliffe receives an average of 6.4 inches of snowfall per year, but typically does not maintain a winter snow pack.

3.2 PHYSIOGRAPHY

The Perry Canyon site is located within the Pah Rah Range, which trends north-south to northwest-southeast (Figure 1-2). The range is located between Pyramid Lake to the northeast and the Warm Springs Valley to the southwest. Mullen Pass separates the Pah Rah Range on the north end from the Virginia Mountains. The Truckee River valley is the southern boundary. Ridge tops to the northeast and southwest of Perry Canyon are at approximately 5,250 feet AMSL. The canyon slopes downward to the northwest from an elevation of approximately 4,900 feet at the Crown Prince adit to 4,500 feet AMSL at the canyon mouth (Figure 1-2). The canyon wall slopes are moderately steep with common loose talus and float. Small tributary drainages are present in the canyon.

3.3 GEOLOGY

A recent summary of the Pyramid Mining District geology is presented in Garside, et al. (2000). Much of the following discussion is extracted from this document. A detailed discussion of the geology of the district is also presented in Bonham and Papke (1969).

The ore deposits of the district are hosted in dacitic to low-silica rhyolite ash-flow tuffs. These tuffs have been informally named the tuff of Perry Canyon, but were previously identified as the Hartford Hill Rhyolite (Bonham and Papke, 1969). The tuffs have been dated at approximately 23 million years old (Garside, et al., 2000). The tuffs of Perry Canyon have been subjected to pervasive propylitic alteration over a large portion of the northern Pah Rah Range. This observation is important to the environmental geochemistry of the site, because a product of propylitic alteration is typically carbonates (commonly calcite) (AGI, 1972). Calcite has specifically been observed associated with the tuffs in the Pyramid District (Wallace, 1980). Therefore, the rock and alluvium in Perry Canyon likely has some neutralizing capacity. More intense argillic and sericitic alteration types are present near the mineralized veins in Perry Canyon.

The mineralization in Perry Canyon is associated with steeply dipping, northwest striking, silicified veins. The veins approximately parallel the dominant northwest-oriented structures (joints and faults) in the canyon area, as well as the canyon itself. The veins commonly contain quartz, pyrite (iron sulfide) barite (barium sulfate), enargite (copper arsenic sulfide), pyrophyllite (hydrate aluminum silicate; a clay-like mineral similar to talc), and diaspore (aluminum oxyhydroxide) (Bonham and Papke, 1969; Garside, et al., 2000). During mining, chalcanthite (hydrated copper sulfate) and selenite (a variety of gypsum; calcium sulfate) formed as the result of accelerated weathering due to the opening of the mines (Bonham and Papke, 1969).

3.4 SURFACE WATER

The Perry Canyon creek channel is the main hydrologic feature of the site. A number of tributary side canyons (gulches) are present. Two of the more significant of these tributaries enter the main drainage at the Crown Prince Mine and approximately one-half mile upstream of the Crown Prince mine (Figure 1-2). The width of the Perry Canyon channel varies from approximately one foot to three or four feet. The channel depth appears to be approximately one foot in the narrower sections. The creek and its tributaries are ephemeral. Continuous flow through the canyon appears to only occur as the result of storm or snowmelt events; however, flow monitoring has not been conducted in the canyon. Small perennial flows appear to occur over short sections of the creek as the result of spring flow. The most apparent of these springs is Cottonwood Spring located approximately one mile upstream of the Crown Prince Mine (Figure 1-2). A small seep flow (< 1-3 gpm) also occurs near the Jones-Kincaid Mine, and seepage from the Crown Prince Mine has periodically been observed. During the dry portions of the year the spring and seep flow is observed to rapidly infiltrate into the creek alluvium. Short sections of surface or near surface alluvial flow occur in the canyon. This may be the result of thinning or absent alluvium.

3.5 GROUNDWATER

Groundwater has been identified in both the alluvium and bedrock in the canyon. Of the four wells drilled along the Perry Canyon creek by the BLM, two were completed completely in tuff (bedrock) and two were completed in alluvium or alluvium and bedrock. The depth to water ranged from 55 feet (MWPC-1) to approximately 17 feet below the ground surface (MWPC-3). Notably, the water levels appear to be below the creek channel, and are therefore consistent with an often dry, losing stream channel.

Flow from both the Jones-Kincaid and Crown Prince mine adits indicate that these mine workings have intersected the bedrock groundwater table within the hillside. Therefore, the mine workings would have lowered the natural groundwater table in the local area to some level at or above the discharge point (the adits). Bonham and Papke (1969) theorized that lowering the water table in the Jones-Kincaid Mine resulted in accelerated oxidation of the sulfides which resulted in acidic, metals-bearing water discharging from the mine. This process is now widely recognized as forming ARD.

3.6 MINE FACILITIES

The Crown Prince Mine site consists of an adit and a waste rock dump. Information on the extent of the Crown Prince Mine workings are apparently not available. The Crown Prince adit portal is partially collapsed and water is impounded behind the collapse. A small volume of seepage through the collapse was evident during a June 25, 2003 site visit, which evaporates and/or infiltrates into the dump material over a distance of a few feet. A small accumulation of efflorescent mineral salts was observed at this location during this site visit.

The Jones-Kincaid adit portal is completely collapsed; however, a small opening was apparently present as recently as 2001 (NBMG, 2003). The Jones-Kincaid has a shaft located on the ridge top to the southwest of the adit (Figure 1-2). The shaft is open to a depth of at least 100 feet. The original dimension of the adit is reported to be over 1,000 feet long, with the shaft approximately 500 feet deep (Bonham and Papke, 1969). Several hundred feet of drifts, a second adit and several shallow shafts are also reportedly associated with the Jones-Kincaid Mine. The location of the second reported adit is unknown; however, there is a possibility that this "second adit" refers to the Crown Prince adit. Seepage occurs just downstream of the Jones-Kincaid adit and waste rock dump.

Accumulation of efflorescent[1] mineral salts was observed at the seepage location and along the toe of the waste rock dump during the June 2003 site visit.

[1] Efflorescent minerals are irregular crystalline minerals produced as a surface encrustation on rocks in arid regions by evaporation of water brought to the surface by capillary action or by loss of water of crystallization on exposure to air.

4.0 PROJECT TASKS

This section provides a brief description of each task presented in the SOW for the project and described in this Work Plan. Detailed information concerning sampling and analysis methodologies associated with each task is provided in the FSP (Appendix A), and the QAPP (Appendix B) provides project controls designed to assure data quality and collection of data representative of site conditions. Data quality objectives for the project are discussed in the QAPP.

4.1 WATER QUALITY SAMPLING

The objective of water quality sampling is to evaluate current water quality conditions at the site for groundwater and surface water (including wells, adit seeps, surface water and natural springs). The following sections present water quality sample quantities and locations.

4.1.1 Surface Water Sampling

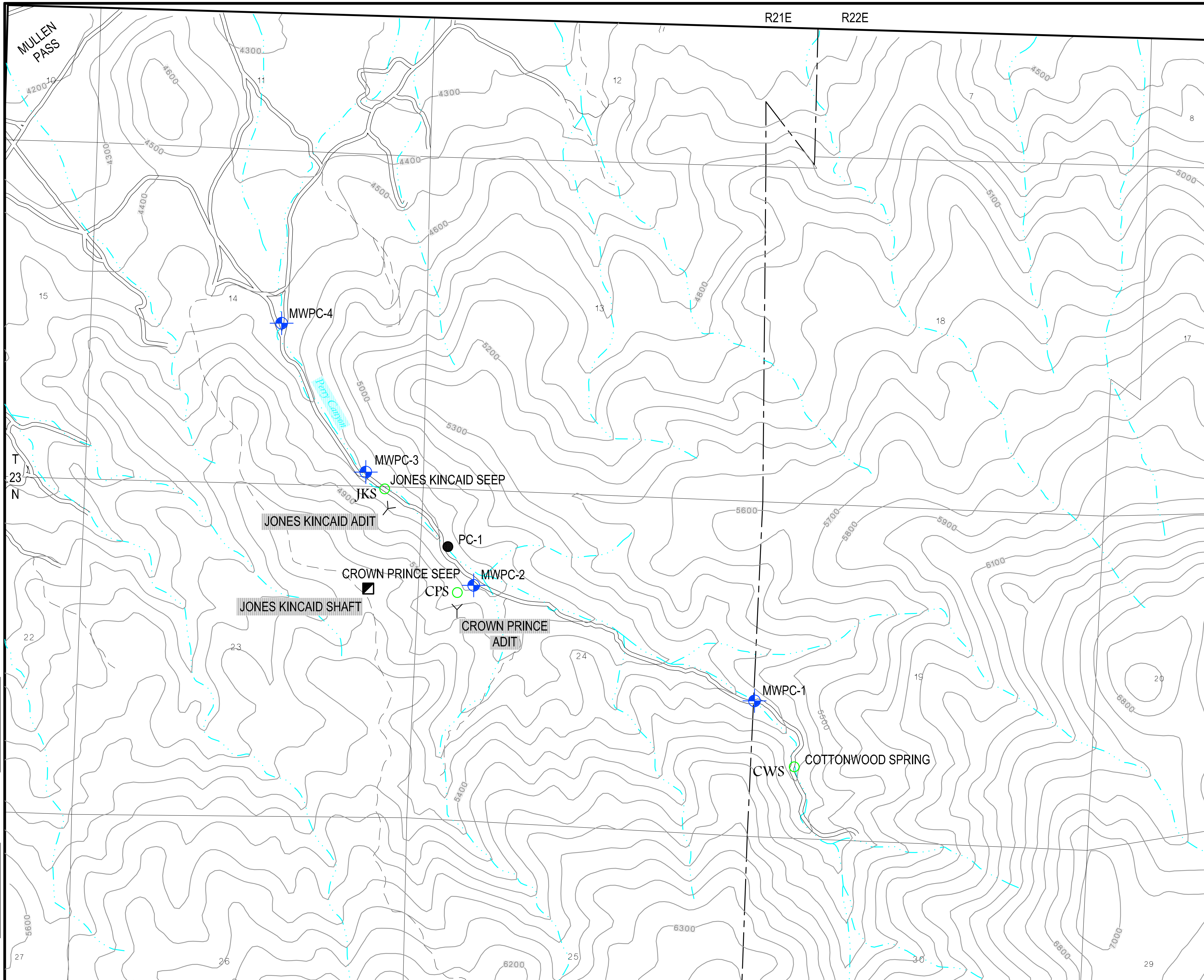
Four quarters of surface water quality sampling will be conducted at the site. Each quarter, one sample will be collected from each of the seeps at the Crown Prince and Jones-Kincaid adits and at the surface water station located below the Crown Prince Mine, if flow is present. In addition, one sample will be collected from the natural spring near the head of the canyon during one of the quarterly sampling events. The sampling locations are illustrated on Figure 4-1, *Sample Location Map*. Global Positioning System (GPS) coordinates will be collected for any station not previously located. Flow will be estimated at each location using an appropriate flow gauging method (i.e., bucket and stopwatch, portable flume, or the area-velocity method with a flow meter). Sample pH, temperature, conductivity, dissolved oxygen (DO) and turbidity will be monitored in the field. In addition, field measurements of oxidation-reduction potential (ORP) may be collected. Samples will be submitted for laboratory analysis of Nevada Profile II parameters excluding cyanide. These parameters are shown in Table 4.1, *Surface Water and Groundwater Quality Parameters*. A complete description of sampling and analytical techniques and requirements for this task is presented in the FSP (Appendix A) and the QAPP (Appendix B).

4.1.2 Monitoring Well Sampling

Water quality samples will be collected from each of the four Perry Canyon groundwater monitoring wells during each of the four quarterly sampling events. The groundwater will be analyzed for field parameters using a flow-through cell. Samples will be submitted to the laboratory and analyzed for Nevada Profile II parameters listed in Table 4.1. Water levels will also be measured in the well before purging and following sample collection. A complete description of sampling and analytical techniques and requirements for groundwater sampling is presented in the FSP (Appendix A) and the QAPP (Appendix B).

4.1.3 Summary of Water Quality Sampling

A summary of water quality sample quantities and locations is provided below in Table 4.2, *Water Sampling Summary*.



LEGEND

STREAM
MINOR ROAD
JEEP TRAIL
MWPC-1 MONITORING WELL
PC-1 SURFACE WATER SAMPLE LOCATION WITH ID NUMBER
CWS SEEP OR SPRING SAMPLE LOCATION WITH ID NUMBER
MINE SHAFT
MINE ADIT

N

SCALE
750' 0 750' 1500'
CONTOUR INTERVAL 100FT.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
1	Issued for Final	8/03	C.Foulk	K.Conrath	C.Foulk
0	Issued for Review	7/03	C.Foulk	K.Conrath	C.Foulk

U.S. ARMY
CORPS OF ENGINEERS

PROJECT:
PERRY CANYON SITE CHARACTERIZATION

DRAWING TITLE:
SAMPLE LOCATION MAP

MWH

Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 4-1

AutoCAD FILE: PC_Samp_Loc.dwg PROJECT NUMBER: 1003797.011801

TABLE 4.1 SURFACE WATER AND GROUNDWATER QUALITY PARAMETERS			
Analyte	Method	MDL (mg/L)	PQL (mg/L)
Alkalinity (Bicarbonate, Carbonate, Hydroxide and Total) *(for samples with field pH > 4.5)*	ASTM Standard Method 2320B	2.0	10
Acidity *(for samples with field pH < or = 4.5)*	ASTM Standard Method 2310B	2.0	10
Chloride Fluoride Sulfate	USEPA 300.0	1.0	5 0.5 20
pH	ASTM Standard Method 4500	0.1	0.1
Total Dissolved Solids	ASTM Standard Method 2540C	10	20
Aluminum Bismuth Boron Calcium Gallium Iron Lithium Magnesium Potassium Scandium Sodium Strontium Tin Titanium	EPA 6010B, ICP-TRACE or EPA 200.7, ICP-MS	0.3 0.1 0.01 0.2 0.1 0.01 0.02 0.2 0.3 0.5 0.3 0.01 0.1 0.005	0.2 0.5 0.05 1 0.5 0.05 0.1 1 1 0.5 1 0.05 0.5 0.03
Antimony Arsenic Barium* Beryllium Cadmium Chromium* Cobalt* Copper* Lead Manganese* Molybdenum* Nickel* Selenium Silver* Thallium Vanadium* Zinc*	EPA 6020, ICP-MS or EPA 200.8, ICP-MS	0.0002 0.0005 0.003 0.0001 0.0001 0.01 0.01 0.01 0.0001 0.005 0.01 0.01 0.0015 0.005 0.00005 0.005 0.01	0.001 0.003 0.01 0.0005 0.0005 0.05 0.05 0.05 0.0005 0.03 0.05 0.05 0.008 0.03 0.0003 0.03 0.05
Mercury	USEPA 245.1	0.0002	0.001
Nitrate – N**	USEPA 300.0 or USEPA 353.2	0.02	0.2
Phosphorus	USEPA 365.3	0.01	0.3
Ferrous Iron *(1st Sampling event only)*	USGS 1-1379-78 or Field HACH Kit	0.005	0.05

Notes:
* Can also be analyzed by method EPA 6010B
** Nitrate may be included with other analytes to be analyzed for using Method 300.0 If received by laboratory within 48 hours of sampling.

Samples will be analyzed for dissolved fraction.
MDL Method Detection Limit
PQL Practical Quantitation Limit
mg/L milligram per liter

TABLE 4.2 WATER SAMPLING SUMMARY				
Location	# Locations	Quarters	Quantity	Parameters
Mine Adit Seeps	2	4	8	• Field Parameters • Flow • Nevada Profile II Parameters
Creek Station CP-1	1	4	4	
Cottonwood Spring	1	1	1	
Monitoring Wells	4	4	16	• Field Parameters • Water Level • Nevada Profile II Parameters

A complete listing of analytical (Nevada Profile II) and field parameters is provided in the FSP (Appendix A) including sample container, preservation and holding time requirements.

4.2 WASTE ROCK CHARACTERIZATION

The waste rock dumps at the Crown Prince and Jones-Kincaid Mines will be characterized to help estimate the volume of material present and the geochemical character of the dump material. This characterization will occur during the first quarterly sampling event unless inclement weather (e.g., snow) would result in more accurate data being collected during a later quarterly event.

4.2.1 Waste Rock Dump Mapping

The Crown Prince and Jones-Kincaid adit waste rock dumps will be mapped using a handheld GPS unit. The toe and crest (upper edge) of the dump will be mapped along with any erosion channels or notable features (e.g., the adits). The maximum height of the dump will be estimated using a staff measuring method. Estimates of the waste rock dump areas and volumes will be calculated using these data.

4.2.2 Geochemical Characterization

A composite sample of waste rock material will be collected from each of the Jones-Kincaid and Crown Prince Mine adit waste rock dumps. These samples will be collected from the surface to 1-foot depth to characterize the portion of the piles that is actively generating ARD (i.e., the near-surface material). Each composite sample will consist of 10 sub-samples distributed over the flanks and tops of the piles. The sub-samples will be composited in the field in 5-gallon buckets with lids. In addition, one duplicate sample will be collected from the Jones-Kincaid dump. The primary and duplicate samples will both be collected by collected alternating scoops of material at the sub-sample locations. Each sub-sample location will have GPS coordinates recorded.

The samples will be analyzed for acid-base accounting (ABA) parameters (including sulfur forms), and leachate using the meteoric water mobility procedure (MWMP) for Nevada Profile II parameters (Table 4.1). The MWMP analysis requires approximately 5-gallons of sample. The ABA analysis requires approximately 200 grams of sample. In addition, an aliquot will be selected for qualitative mineralogical evaluation using visual methods. A complete description of field sampling and analytical procedures and requirements associated with this task is presented in the FSP (Appendix A) and the QAPP (Appendix B).

4.3 EFFLORESCENT MINERAL SAMPLING

One sample will be collected of the efflorescent mineral at both the Crown Prince and Jones-Kincaid Mines, respectively. Each sample will be analyzed for total metals concentrations listed in Table 4.3, *Efflorescent Mineral Analytical Parameters*. Where different colored salts are present at an individual location, approximately equal volumes of the different colored materials will be composited. Approximately 8-ounces of sample material will be required for analysis. The sample locations will be recorded using a handheld GPS unit. A complete description of field sampling and analytical procedures and requirements associated with this task is presented in the FSP (Appendix A) and QAPP (Appendix B).

TABLE 4.3
EFFLORESCENT MINERAL ANALYTICAL PARAMETERS

Analyte (Total Metals)	Analytical Method	Reporting Limit (mg/kg)
Antimony	USEPA 6010B and 6020	0.1
Arsenic		4
Cadmium		0.5
Copper		2
Lead		0.1
Manganese		0.8
Nickel		2
Selenium		4
Silver		1
Zinc		2
Mercury	EPA 7471 CVAA	0.01
Note: Equivalent method may be used to achieve required detection limits.		

5.0 PROJECT SCHEDULE

A project schedule has been prepared for implementation of work presented in this Work Plan and is presented in Figure 5-1, *Project Schedule*.

5.1 FIELD INVESTIGATIONS

Field investigation activities will begin following approval of this Work Plan. Field investigation work is currently scheduled to begin in early September 2003 and will be completed after the four quarters of sampling, as shown on the project schedule. If the sampling begins in early September, the fourth quarterly event will be completed in early June 2004.

5.2 REPORTS

Two iterations of the Site Characterization Report will be developed after completion of the field work described in this Work Plan. The draft report will be submitted approximately six weeks after the completion of field work. Providing for review and revision of the draft report, the final report will be submitted in early September 2004. The submittal dates and periods for review are provided on the project schedule.

FIGURE 5-1
PROJECT SCHEDULE - PERRY CANYON SITE CHARACTERIZATION

	WEEK OF									WEEK OF				WEEK OF																
ACTIVITY	6/23/03	6/30/03	7/7/03	7/14/03	7/21/03	7/28/03	7/28/03	8/4/03	8/11/03	9/8/03	12/1/03	3/1/04	6/1/04	6/7/04	6/14/04	6/21/04	6/28/04	7/5/04	7/12/04	7/19/04	7/26/04	8/2/04	8/9/04	8/16/04	8/23/04	8/30/04	9/6/04	9/13/04	9/20/04	9/27/04
Site Visit (6/25/03)	■																													
Prepare & Submit Draft SAP & SSHP (Plans)		■	■																											
Comments Due on Plans				X																										
Conference Call					X																									
Response to Comments						■																								
Prepare & Submit Final Plans							■	■																						
Approval of Plans									■																					
First Quater Sampling										X																				
Second Quater Sampling											X																			
Third Quater Sampling												X																		
Fourth Quater Sampling													X																	
Prepare & Submit Draft Report														■	■	■	■	■	■											
Comments Due on Report																							X							
Conference Call																									X					
Response to Comments																										■	■			
Prepare & Submit Final Report																													■	

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APPENDIX A

FIELD SAMPLING PLAN

APPENDIX A

FIELD SAMPLING PLAN

PERRY CANYON SITE INVESTIGATION
USACE CONTRACT NO. DACW45-03-D-0001

August 2003

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LIST OF TABLES

1.0 INTRODUCTION

This Field Sampling Plan (FSP) for the Perry Canyon Site Investigation Work Plan (Work Plan) describes procedures that will be used to assure that samples representative of the physical and chemical characteristics of site media are collected. The main activities associated with the FSP are as shown below:

- Water quality monitoring
- Waste rock characterization
- Efflorescent mineral (precipitant) sampling

The objective of the sampling and work presented in this FSP is to provide the information necessary for development of a Site Characterization Report for the Perry Canyon site that will include a discussion of impacts and preliminary recommendations for site remediation. The issues and media addressed include surface water (adit seeps, springs and periodic creek flow), groundwater, waste rock, and efflorescent minerals that have formed in association with the adit discharge. Sampling procedures for characterization of these media are presented in this FSP.

As a general practice, MWH field personnel will make daily reports to both the MWH Project Manager and the USACE Project Manager (Nardin) during field activities. Any problems or modification to this Work Plan will be discussed and/or resolved prior to demobilizing from the field.

2.0 WATER QUALITY SAMPLING

The data quality objectives for the groundwater and surface water sampling are to obtain additional physical and chemical data for the characterization of the Perry Canyon site.

2.1 OBJECTIVES OF THE WATER QUALITY SAMPLING PROGRAM

The primary objectives of the water sampling program are to supplement existing data and develop new water quality data characterizing the site over one annual period, and to collect data pertaining to potential sources of ARD at the site. Water monitoring will be conducted at the following locations:

- Seepage from the Crown Prince adit;
- Seepage below the Jones-Kincaid adit;
- Periodic stream flow between the Crown Prince and Jones-Kincaid Mines;
- Upgradient spring flow in Perry Canyon (1 event only); and
- Four downgradient and upgradient groundwater monitoring wells (MWPC-1 through MWPC-4).

2.2 WATER QUALITY SAMPLING ACTIVITIES AND PROCEDURES

The water monitoring program will include measurement of field water quality parameters, flow, groundwater levels and collection of groundwater and surface water samples for laboratory analysis. All activities will follow the procedures summarized below and detailed in the project standard operating procedures (SOPs). SOPs that cover water monitoring activities are presented in Appendix D and include the following:

- SOP-1, Collection of Surface Water Samples
- SOP-2, Collection of Groundwater Samples
- SOP-3, Surface Water Flow Measurement
- SOP-4, Collection of Water Level Measurement Data

The SOPs provide general procedures that will be followed during sample collection. The FSP provides specific instructions for sample collection based on the current understanding of site conditions at the Perry Canyon site.

The following procedures will be required during all sampling events:

- Sampling equipment will be decontaminated prior to and between sampling locations using an Alconox wash and distilled water rinse.
- Water quality meters will be rinsed with DI water before and after collecting measurements.
- Field information will be recorded on the sample collection form or groundwater purge record and/or in a field notebook. Samples will be logged on a chain of custody form. The samples will be kept secure in the custody of the sampler until they are transferred to the laboratory via overnight courier.

- Quality Assurance/Quality Control (QA/QC) samples will be collected and handled in a similar manner as the primary sample.

2.2.1 Surface Water

Surface water samples will be collected from each of the adit seeps, spring and creek locations described above. For the adit seeps and spring, the samples will be collected as close to the discharge point as practicable. The spring sample will be collected during one of the quarterly sampling events, preferably the first event. When this sample is collected, it will be the first sample collected to reduce the potential for cross contamination, as it represents a "background" sample. If flow or standing water is present in the creek location between the Crown Prince and Jones-Kincaid Mines, a sample will be collected at that station (station PC-1). The surface water samples for laboratory analyses will be collected in accordance with SOP-1 and the specific information presented within this FSP.

2.2.1.1 Sample Collection

Surface water samples will be collected prior to recording field parameters or measuring flow. Only dedicated sampling equipment will be used. The primary method for collecting surface water samples will be the grab-collection method. If a peristaltic pump is used, a portable battery powered unit should be incorporated such that it can be located directly adjacent to the sample location. The intake tubing can then be lowered into the desired sample location and the sample pumped directly into the sample container(s). Alternatively, a dedicated sample container can be used to collect the sample, which can then be transferred to the sample container(s). Samples requiring filtration will be field-filtered using a peristaltic pump or hand-held vacuum apparatus and 0.45 micron disposable cartridge-type filters. Dedicated disposable Teflon-lined tubing along with a short section of medical grade silicon tubing through the pump will be used to collect and filter samples when using a peristaltic pump.

2.2.1.2 Field Parameter Measurement

Field water quality parameters will be measured at surface water sampling locations. The field parameters to be measured include the following:

- Conductivity;
- Dissolved oxygen (DO);
- pH;
- Temperature; and
- Turbidity.

A Horiba U-10 meter, or equivalent, will be used to collect the field parameter data. If provided by the meter used, Eh (or ORP) and salinity may also be recorded. Field parameter measurements will occur in-situ whenever possible by lowering the decontaminated meter into the water. If necessary, a depression in the flowing channel may be created to accommodate the in-situ measurement. However, sufficient flow should be allowed to pass through the depression to remove any turbidity created by the disturbance. If an in-situ measurement is not possible, then the measurement will be made at the monitoring site using a decontaminated high-density polyethylene (HDPE) beaker to collect the sample for parameter measurement. Measurements will be recorded on the sample collection log and/or in the field notebook. Field meters will be used in accordance with the manufacturer's instruction. Meters will be calibrated at a minimum of once per day before use in the field.

2.2.1.3 Flow Measurements

Flow measurements will be recorded at all flowing surface water monitoring locations. Volumetric methods or portable flume methods will be used to measure flow. The bucket and stop-watch technique is the typical volumetric method. Three consecutive measurements of flow volume, over similar time durations will be made. All flow in the drainages will be captured in the container during the period of measurement. For a portable flume, the flume will be placed in the drainage and leveled. A soil dam will then be constructed to direct all flow through the flume and the gauge height in the flume will be recorded. A flow can then be calculated using the gauge height and flume-specific equation. The flow through the flume should be allowed to equilibrate prior to the gauge height measurement, and an estimate of any leakage around the flume (percent) will be made. Given the drainage size and flows observed at the site, these methods would be appropriate in most cases. Under higher flow conditions, an area-velocity method using a flow meter may be utilized. SOP-3 (Appendix D) provides additional detail on surface water flow measurement.

2.2.2 Groundwater

Four groundwater samples per quarter will be collected from the Perry Canyon monitoring wells (MWPC-1 through MWPC-4). All of the wells are constructed of 2-inch diameter PVC casing and screen. The maximum depth to water in the wells is 55 feet below ground level, and the wells have approximately 10 to 45 feet of standing water. The well reports and logs are included in Appendix E of the Work Plan.

The wells will be purged by pumping prior to sampling. Typically, three well-casing storage volumes are purged from a well prior to sampling. However, some or all of the wells in Perry Canyon yield low quantities of water. In the case where a well purges dry, sampling may be conducted after the well has recharged sufficiently to provide a sample.

The water level and total well depth will be measured (or estimated) before purging and the well casing volume (CV) will be calculated as follows:

$$CV = 23.5\ r^2h$$

where:	CV	= casing volume (gallons)
	r	= casing radius (feet)
	h	= water column height (total well depth - depth to water) (feet)
	23.5	= p x 7.48 (to convert from cubic feet to gallons)

2.2.2.1 Sample Collection

Field parameters will be collected at the start of purging and at appropriate intervals based on the volume of water to be purged. Field parameters (pH, conductivity, temperature, DO and turbidity) will be recorded using a water quality meter and a flow-though cell. In this way representative field parameter measurements can be collected. Typically parameters will stabilize within one to three well volumes. Field parameter stabilization criteria include:

- pH – within 0.2 units
- Conductivity – within 10 percent
- DO – within 10 percent
- Temperature – within 0.5°Celsius

An attempt will be made to stabilize the parameters within the purging interval. If parameters do not stabilize by the end well purging, the sample will be collected and field parameters will be recorded. It is assumed that if the well purges dry, all new water flowing into the well will be representative of the in-situ groundwater. The relatively small volume of purge water will be discharged to the ground surface where it will evaporate or infiltrate to the groundwater.

Samples will be collected through the pump tubing after purging is complete and the wells have recovered sufficiently to collected the needed sample volume. Samples requiring filtration will be field-filtered using 0.45-micron disposable cartridge-type filters. Samples will be pumped directly into the sample containers. SOP-2 (Appendix D) provides specific guidelines for groundwater sample collection, including decontamination, bottle handling, etc.

2.2.2.2 Groundwater Level Measurement

Water level measurements will be recorded during groundwater sample collection. Water levels will be measured prior to purging and again following sampling. Measurements will be made using an electronic water level sounder and recorded on the sample collection form and/or field logbook. The location of the reference point being used will be noted and recorded (i.e. the height of the reference point above ground surface). Groundwater level measurements will be referenced to the top of casing or other appropriate reference. Total well depth will also be measured and recorded, during the first of the four sampling events. SOP-4 (Appendix D) provides additional specific guidelines for collecting water level measurements.

2.3 WATER QUALITY SAMPLING QA/QC

One field duplicate will be collected from one of the water monitoring sites per event to assist in determining the quality of collection methods and laboratory data. In addition, one equipment rinseate blank will be collected during the first water-sampling event. If results indicate any significant contamination then additional rinseate blanks may be included in subsequent events. For the equipment rinseate sample, deionized water will be run through the pump and flow-through cell, field filtered, and collected in the appropriate containers for analysis. The duplicate sample and equipment blank will be submitted blind to the laboratory as separate samples by using an alternate sample identification.

2.4 WATER ANALYSES

Surface water and groundwater samples will be analyzed for Nevada Profile II parameters. The metals analyses will be for the dissolved fraction (field filtered). Table A.1, *Nevada Profile II Parameters*, presents the water sample analytical list, methods and detection limits. Samples with field pH of less than or equal to 4.5 will be tested for acidity, whereas samples above pH 4.5 will be tested for alkalinity.

TABLE A.1
NEVADA PROFILE II PARAMETERS

Parameter	Fraction	Method	Detection Limit	Units
GENERAL CHEMISTRY AND ANIONS				
Alkalinity (see note 1)		SM 2320B	2.0	mg/l (as $CaCO_3$)
Acidity (see note 2)		SM 2310B	2.0	mg/l (as $CaCO_3$)
Chloride		EPA 300.0	1.0	mg/l
Fluoride		EPA 300.0	0.1	mg/l
Nitrate (NO3 + NO2 as N)		EPA 353.2	0.02	mg/l
pH		SM 4500	0.1	Std. Units
Phosphorus (total as P)		EPA 365.1	0.01	mg/l
Sulfate		EPA 300.0	10.0	mg/l

TABLE A.1 NEVADA PROFILE II PARAMETERS				
Parameter	**Fraction**	**Method**	**Detection Limit**	**Units**
Total Dissolved Solids (TDS)		EPA 160.1 or SM 2540C	10	mg/l
		CATIONS AND TRACE METALS		
Aluminum	Dissolved (field filtered)	EPA 6010B, ICP	0.3	mg/l
Antimony		EPA 6020, ICP-MS	0.0002	mg/l
Arsenic		EPA 6020, ICP-MS	0.0005	mg/l
Barium		EPA 6010B, ICP	0.003	mg/l
Beryllium		EPA 6020, ICP-MS	0.0001	mg/l
Bismuth		EPA 6010B, ICP	0.1	mg/l
Boron		EPA 6010B, ICP	0.01	mg/l
Cadmium		EPA 6020, ICP-MS	0.0001	mg/l
Calcium		EPA 6010B, ICP	0.2	mg/l
Chromium		EPA 6010B, ICP	0.01	mg/l
Cobalt		EPA 6010B, ICP	0.01	mg/l
Copper		EPA 6010B, ICP	0.01	mg/l
Gallium		EPA 6010B, ICP	0.1	mg/l
Iron (see note 3)		EPA 6010B, ICP	0.01	mg/l
Lead		EPA 6020, ICP-MS	0.0001	mg/l
Lithium		EPA 6010B, ICP	0.02	mg/l
Magnesium		EPA 6010B, ICP	0.2	mg/l
Manganese		EPA 6010B, ICP	0.005	mg/l
Mercury		EPA 245.1,CVAA	0.0002	mg/l
Molybdenum		EPA 6010B, ICP	0.01	mg/l
Nickel		EPA 6010B, ICP	0.01	mg/l
Potassium		EPA 6010B, ICP	0.3	mg/l
Scandium		EPA 6010B, ICP	0.5	mg/l
Selenium		EPA 6020, ICP-MS	0.0015	mg/l
Silver		EPA 6010B, ICP	0.005	mg/l
Sodium		EPA 6010B, ICP	0.3	mg/l
Strontium		EPA 6020, ICP-MS	0.00005	mg/l
Thallium		EPA 6020, ICP-MS	0.00005	mg/l
Tin		EPA 6010B, ICP	0.1	mg/l
Titanium		EPA 6010B, ICP	0.005	mg/l
Vanadium		EPA 6010B, ICP	0.005	mg/l
Zinc		EPA 6010B, ICP	0.01	mg/l

Notes:
1 – Alkalinity will be analyzed in samples with field pH greater than 4.5. Carbonate, bicarbonate and total alkalinity will be reported.
2 – Acidity will be analyzed in samples with field pH less than or equal to 4.5
3 – Ferrous iron will also be measured during one of the sampling events using a field Hach kit (Method 8146), or using USGS Method 1-1379-78

2.5 SAMPLE IDENTIFICATION AND LABELING

Water samples will be collected, preserved and stored as indicated in Table A.2, *Water Sample Control and Preservation.*

TABLE A.2 WATER SAMPLE CONTROL AND PRESERVATION			
Parameter	Maximum Holding Time	Storage Conditions	Filtration/Preservatives
Total Dissolved Solids	28 days	4°C	Filtered/none
Sulfate, Chloride, Fluoride	28 days	4°C	Filtered/none
Dissolved Metals	6 months	4°C	Filtered/HNO_3 to pH < 2
Phosphorus, Nitrate + Nitrite	28 days	4°C	Unfiltered/ H_2SO_4
Mercury	28 days	4°C	Filtered/HNO_3 to pH < 2
Alkalinity, Acidity and pH	14 days	4°C	Unfiltered/none

Samples will be labeled in the field based on the following principles:

	Example
• Date	071502
• Site Name	PC
• Sample Number	01 (normal sample) 02 (field duplicate) 03 (equipment blank)

The sites will be designated as follows:

- Monitoring wells — MWPC1 through MWPC4
- Jones-Kincaid Seep — JKS
- Crown Prince Seep — CPS
- Cottonwood Spring — CWS
- Perry Canyon Stream Station — PC1

Therefore, a groundwater sample collected from monitoring well MWPC1 on October 30, 2003, will be designated as 103003-MWPC1-01.

A summary of water quality sample quantities and locations proposed for the current scope of work is provided below in Table A.3, *Water Sampling Summary*.

TABLE A.3
WATER SAMPLING SUMMARY

Location	Quantity	Quarters	Parameters
Monitoring Wells	4	4	Field Parameters Water Level Nevada Profile II Parameters
Adit Seeps	2	4	Field Parameters Flow Nevada Profile II Parameters
Spring	1	1	Field Parameters Flow Nevada Profile II Parameters
Stream (if flowing)	1	4	Field Parameters Flow Nevada Profile II Parameters
QA/QC (surface water) (equipment blank and field duplicate)	2	4	Field Parameters (field duplicate only) Nevada Profile II Parameters (metals only for equipment blank)

3.0 WASTE ROCK AND EFFLORSCENT MINERALS CHARACTERIZATION

Samples will be collected from the Crown Prince and Jones-Kincaid waste rock dumps and of the efflorescent minerals (precipitants) that have formed in the area of the mine adits. The waste rock will be tested for geochemical parameters that relate to AMD generation. In addition, the approximate dimensions of the waste rock dumps will be measured. The efflorescent minerals will be tested for total metals concentrations. Lists of these test parameters and analyses are presented in Tables A.4 and A.5, below. Sampling and analysis details for each area are discussed in the following sections, and general guidelines for soil (solids) sampling are provided in SOP-5 (Appendix D).

TABLE A.4
WASTE ROCK GEOCHEMICAL ANALYSES

Test	Parameters
Acid-Base Accounting (ABA)	Sulfide-S, Total Sulfur, Acid Neutralization Potential (ANP), Acid Generating Potential (AGP), Net Neutralization Potential (NNP)
MWMP	Nevada Profile II Parameters (see Table A.1)

TABLE A.5
EFFLORESCENT MINERALS ANALYSES

Parameter	Fraction	Method	Detection Limit	Units
Antimony	Total	EPA 6020, ICP-MS	0.1	mg/kg
Arsenic		EPA 6010B, ICP	4	mg/kg
Cadmium		EPA 6010B, ICP	0.5	mg/kg
Copper		EPA 6010B, ICP	2	mg/kg
Lead		EPA 6020, ICP-MS	0.1	mg/kg
Manganese		EPA 6010B, ICP	0.8	mg/kg
Mercury		EPA 7470, CVAA	0.04	mg/kg
Nickel		EPA 6010B, ICP	2	mg/kg
Selenium		EPA 6010B, ICP	4	mg/kg
Silver		EPA 6010B, ICP	1	mg/kg
Zinc		EPA 6010B, ICP	2	mg/kg

3.1 WASTE ROCK EVALUATION

The waste rock dumps at the Crown Prince and Jones-Kincaid Mines will be characterized to help estimate the volume of material present and the geochemical character of the dump material. This characterization will occur during the first quarterly sampling event unless inclement weather (e.g., snow) would result in more accurate data being collected during a later quarterly event.

3.3.1 Waste Rock Pile Mapping

The Crown Prince and Jones-Kincaid waste rock dumps will be mapped using a handheld GPS unit. The toe and crest (upper edge) of the dumps will be mapped along with any erosion channels or notable features (e.g., the adits). Sufficient GPS points will be selected so that the shape of the dump can be approximated. The maximum height of the dump will be estimated using a staff measuring method. A staff of known length (e.g., 5 feet) will be used with a hand level to measure the dump height in unit staff lengths, with the residual approximated. Utilizing the maximum height, the toe and crest configuration and approximate topography of the natural ground surface, a volume will be estimated.

3.3.2 Geochemical Characterization

A composite sample of waste rock material will be collected from each of the Jones-Kincaid and Crown Prince Mine adit waste rock dumps. These samples will be collected from the surface to 1 foot depth to characterize the portion of the piles that is actively generating ARD (i.e., the near-surface material). Each composite sample will consist of 10 sub-samples distributed over the flanks and tops of the dumps. GPS coordinates of the sampled area will be recorded. A shovel will be used to collect the sub-samples. At locations where the dump material has consolidated, a pick may be required to break-up the waste rock. The sub-samples will be composited in the field in 5-gallon buckets with lids or in Ziploc™ bags. Between dumps the equipment will be decontaminated. For the purpose of evaluating quality control, one duplicate sample will be collected from the Jones-Kincaid dump composite sample. The primary and duplicate samples will both be collected from the composited sample.

The samples will be analyzed for acid-base accounting (ABA) parameters (including sulfur forms), and leachate using the meteoric water mobility procedure (MWMP) for Nevada Profile II parameters (Table A.4). The MWMP analysis requires approximately 5-gallons of sample, and one bucket composite will be dedicated to the MWMP analysis. The ABA analysis requires a smaller mass of approximately 200 grams. A second bucket will be used to composite this sample, if needed. After collection the ABA sample will be mixed in the bucket and a 200-gram aliquot will be collected and placed in a separate container for analysis. In addition, an aliquot will be collected for qualitative mineralogical evaluation in the office using visual methods. Each sample will be documented on a field form and in the field notebook. Field descriptions of the waste rock will include at a minimum, grain size, degree of cementation, depth of weathering, and formation of secondary minerals and hardpans.

3.2 EFFLORESCENT MINERALS SAMPLING

One sample will be collected of the efflorescent mineral salts at both the Crown Prince and Jones-Kincaid Mines, respectively. Each sample will be analyzed for total metals concentrations listed in Table A.5, *Efflorescent Mineral Salt Analyses*. Where different colored salts are present at an individual dump location, approximately equal volumes of the different colored materials will be composited. Samples will be collected by gloved hand, using a rock pick to dislodge the materials, if needed. The samples will be placed directly into the sample jar. Care will be taken to reduce the amount of non-mineral matter and native geologic materials included in the sample. Approximately 8-ounces of sample material will be required for analysis. The sample locations will be recorded using a handheld GPS unit.

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

PERRY CANYON SITE INVESTIGATION
USACE CONTRACT NO. DACW45-03-D-0001

August 2003

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1.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) for the Perry Canyon Site Investigation Work Plan documents project management and organization, identifies the procedures used to assure the accuracy, precision and representativeness of the data collected and assures the procedures provided in the FSP are implemented so that the project Data Quality Objectives (DQOs) are achieved. The QAPP presents an overall description of the methods, responsibilities and procedures associated with the field characterization activities at the Perry Canyon Site near Pyramid Lake, Nevada. Accordingly, this QAPP reflects MWH's current corporate standards and procedures for the implementation of these investigations, appropriate regulatory requirements and methods that have developed through experience on similar environmental programs. It is the responsibility of all project personnel either performing or overseeing sampling and analysis activities to adhere to the requirements of this QAPP and supporting project-specific documents.

1.1 PROGRAM MANAGEMENT

1.1.1 Project Organization

Effective project management is key to implementation of the sampling and analysis program. It provides all parties involved with a clear understanding of their role in the investigation and provides the lines of authority and reporting for the project. Key positions and associated responsibilities are outlined below.

<u>Bureau of Land Management Project Manager – Terry Neumann</u>

- Review and approve work plan and deliverables
- Review project technical and data reports
- Provide project oversight

<u>United States Army Corps of Engineers Project Manager – Carl Nardin</u>

- Assure delivery of data and project deliverables to BLM
- Issue and oversee contractual issues
- Review project technical and data reports
- Provide project oversight

<u>MWH Technical Manager – Cary Foulk</u>

- Provide oversight of all technical deliverables
- Implement necessary actions and adjustments to accomplish project objectives

<u>MWH Project Quality Assurance (QA) Manager – Pamela Anderson</u>

- Work closely with the Technical Manager to assure that data are available on time
- Assure that the appropriate field QA samples are collected per project SOPs
- Receive laboratory deliverables and pertinent field data
- Coordinate and oversee electronic data management system

<u>MWH Field Coordinator – Pamela Anderson</u>

- Assure sampling events are completed and all necessary data are collected
- Verify QA procedures are followed during sample collection
- Report difficulties/complications in sample collection to Technical Manager
- Assure chain-of-custody forms and field books are filled out properly

Analytical Laboratory(s)

- Responsible for off-site analysis of samples
- Deliver analytical results in a timely manner
- Calibrate and maintain laboratory equipment
- Conduct internal Quality Assurance/Quality Control (QA/QC) procedures
- Notify QA Manager when problems occur
- Assure data and QA information are properly recorded
- Assure all custody records are properly completed and handled

1.1.2 Special Training Requirements/Certification

All personnel who enter an abandoned mine site must recognize and understand the potential hazards to health and safety associated with the site. Employees working on sites exposed to hazardous substances, health hazards, or safety hazards; their supervisors; and management responsible for the site will, at all times of assignment to the field, meet at a minimum the Occupational Safety and Health Administration (OSHA) hazardous waste site workers 40-hour training requirement. Additional training requirements specified in the Site Specific Health and Safety Plan (Appendix C) will be completed as necessary. Sampling personnel will be trained in the use of industry-standard practices. A qualified geologist or engineer will provide sampling oversight.

1.1.3 Problem Definition and Background

Background information for the Perry Canyon project and a description of the media requiring analytical sampling are provided in Section 1.0 of the Work Plan.

1.1.4 Project Description

Field monitoring and sampling will be conducted to support the field investigation and development of a Site Characterization Report. The purpose of the field monitoring and sampling will be to determine the current site conditions as they relate to potential mining-related impacts to surface water and groundwater in Perry Canyon. Descriptions of the project and investigative activities to be performed are provided in Section 4.0 of the Work Plan.

1.1.5 Criteria for Measurement Data

MWH will utilize a Nevada Department of Environmental Protection (NDEP) certified laboratory to analyze samples collected at the Perry Canyon Site. The laboratory used will be ACZ Laboratories of Steamboat Springs, Colorado. The laboratory and its staff have the responsibility to process all samples submitted according to the specific protocols for sample custody, holding times, analysis and associated laboratory quality assurance. Designated laboratory personnel will maintain contact with the Project QA Manager to assure that internal laboratory DQOs are achieved. Laboratory DQOs are defined in terms of accuracy and precision. Accuracy and precision will be assessed through the use of field quality assurance samples and consistent laboratory practices.

Table B.1, *Summary of Analytical Schedule*, presents sampling location, sample matrix, test parameters, number of samples including QA/QC samples and reference to an analyte list.

Table B.2, *Sample Requirements*, presents analytical methods, container type, preservation of media, minimum sample volume, and maximum holding time.

TABLE B.1
SUMMARY OF ANALYTICAL SCHEDULE
PERRY CANYON SITE, NEVADA

Staff Location	Sample Matrix	Test Parameters	Number of Sampling Events	Total Estimated Number of Samples	Field Duplicates	Reference
Water Quality Data						
Mine Adit Seepage (2 Locations)	water	Nevada Profile II Parameters/ Field Parameters	4	8	4	FSP, Table A.1 and A.3
Groundwater Wells (4 wells)		Nevada Profile II Parameters/ Field Parameters	4	16		
Stream Location Between Mines		Nevada Profile II Parameter/ Field Parameters	4	4		
Cottonwood Spring		Nevada Profile II Parameter/ Field Parameters	1	1		
QA/QC Sample (Equipment Blank)		Nevada Profile II (Metals Only)	4	4		
Waste Rock						
Crown Prince and Jones-Kincaid Waste Rock Piles	rock	Geochemical (ABA, MWMP)	1	2	1	FSP, Table A.1
Efflorescent Minerals						
Below Crown Prince and Jones-Kincaid Adits	solids	Total Metals (Sb, As, Cd, Cu, Pb, Mn, Hg, Ni, Se, Ag, Zn)	1	2	--	FSP, Table A.2

Notes:
FSP - Field Sampling Plan
ABA - Acid Base Accounting
MWMP - Meteoric Water Mobility Procedure
QA/QC - Quality Assurance / Quality Control

TABLE B.2
REQUIREMENTS FOR SAMPLING CONTAINERS
PERRY CANYON SITE, NEVADA

	Matrix	Container Type	Minimum Sample Volume	Preservation	Maximum Holding Time
Metals (Sb, As, Cd, Cu, Pb, Mn, Hg, Ni, Se, Ag, Zn) - Methods SW6010B, 6020, 7470	Solids	Glass jar	100 g	None	mercury - 28 day others - 6 months
MWMP	Soil/Rock	5-gallon bucket	5 kg	None	NA
Nevada Profile II	Water	Various polyethylene bottles	Filtered: - 250 mL - 125 mL Unfiltered: - 500 mL - 250 mL -500 mL	Filtered: - unpreserved - HNO_3 (following filtration) Unfiltered: - unpreserved - HNO_3 - H_2SO_4	NA
ABA (Acid Base Accounting)	Soil/Rock	Glass jar or plastic bag	200 g	None	NA

Notes:

g - gram
kg - kilogram
lbs - pounds
mL - milliliter
oz - ounce

MWMP - Meteoric Water Mobility Procedure
HNO_3 - nitric acid
H_2SO_4 - sulfuric acid
NA - Not applicable

Table B.3, *Water Monitoring Field Parameters*, lists the measurement performance criteria for field water quality monitoring.

TABLE B.3
WATER MONITORING FIELD PARAMETERS
PERRY CANYON SITE, NEVADA

Parameter	Performance Criteria Reference	Detection Limit
Conductivity	EPA 120.1	1.0 µS/cm
Dissolved Oxygen	EPA 360.1	0.1 mg/L
pH	EPA 150.1	0.1 units
Temperature	Standard Methods 212	0.1 °C
Turbidity	Standard Methods 2130B	0.1 NTU
Flow	Volumetric Flow or Flume	Method Dependent
Water Level	ASTM Method	NA
NA = non applicable		

1.1.6 Data Quality Objectives

Data quality objectives (DQOs) are a series of statements that define the type and quality of samples that will be collected during field work, clarify the objectives of the sampling effort and specify acceptable limits of uncertainty. DQOs are quantitative and qualitative statements that specify the quality of the data required to support decisions during the project. The DQOs were developed following the guidance contained in the document *USEPA Guidance for the DQO Process*, USEPA QA/G-4 (USEPA/600R-96/055).

Project objectives have dictated the sampling and analytical methods and QA/QC procedures that will be followed. The DQO approach was developed by the USEPA as a tool to aid planning and decision-making related to data collection. A primary objective of this QAPP is to help ensure that the collected data are of sufficient quality to support site characterization and preliminary recommendations of remedial measures, if needed. The seven-step process for developing DQOs and their remedies is presented in Table B.4, *Data Quality Objectives*.

1.2 MEASUREMENT/DATA ACQUISITION

1.2.1 Sample Handling and Custody Requirements

Sample handling and chain-of-custody procedures will be strictly adhered to during sample collection, transportation and laboratory handling to assure the identity of the samples. Improper sample and data handling and inadequate chain-of-custody procedures affect the credibility and acceptability of analytical results, regardless of their accuracy or precision.

All samples will be appropriately labeled with pre-prepared labels. Each label will include the project name, time and date of collection, sample depth (if applicable), sample identification number, preservative (if applicable), analyses to be performed, and the initials of the sampler. The chain-of-custody record (COCR) will be initiated by the field sampling personnel upon collection of a sample and will accompany each shipping container. The sampling personnel will retain a copy of the COCR and send the original with the sample shipment.

TABLE B.4
DATA QUALITY OBJECTIVES

Task	DQO Step	Investigation Statement	Work Plan Reference
Water Quality Sampling	State the Problem	Meteoric waters, after coming into contact with mine materials and mine workings may contain elevated concentrations of dissolved metals, low pH and other constituents of potential concern that could potentially affect water resources including downstream groundwater supplies.	Section 4.1
	Identify the Decision	Data collected during this project will be used to characterize the sources and related impacts in the canyon and potential downgradient areas. These data may be used to prioritize remedial actions.	
	Identify Inputs to the Decision	Four quarters of sampling from four wells in Perry Canyon, mine discharges, surface water flow, and spring flow (1 quarter) will be collected. These data will be complied and evaluated with the other site information obtained from historical and other data collection efforts. Laboratory results will be compared to internal laboratory control sample criteria, duplicates and field blanks to determine if data are consistent and usable. Water quality trend evaluations using graphical representations, loading analyses and geochemical modeling are tools that may be used to develop the decision.	
	Define the Study Boundaries	Study boundaries are the monitoring well locations, springs and seeps identified and the single stream sampling location.	
	Develop a Decision Rule	Data collected will provide the basis for characterization of the site during baseflow conditions quarterly for one annual period. Baseflow water quality conditions will be characterized. If not, additional study may be needed.	
	Specify the Limits on Decision Error	Limits on analytical error are the internal laboratory DQOs including control limits for MS/MSD and LCS percent recovery, surrogate percent recovery, and detection limits. High data quality standards will be maintained. However, the DQO of characterization allows for a broad range of data quality to be used including historical data of unknown quality. Relative differences in concentrations will be most critical to characterization evaluations.	
	Optimize the Design	Sampling over one annual period is expected to address seasonal variability that may occur at the site and reduce the impact of data outliers if they occur. Sufficient data are expected to be generated to meet the DQOs.	
Waste Rock Characterization	State the Problem	Waste rock dumps at the Crown Prince and Jones-Kincaid adits may be acid generating and provide metals loading to Perry Canyon. Data are needed to characterize the acid generating potential and identify the metals being released from the waste rock.	Section 4.2
	Identify the Decision	Samples will be collected to characterize the acid-base characteristics of the waste rock and the metals leaching from the rock. These data may be used to help prioritize the need for remedial measures related to the waste rock.	
	Identify Inputs to the Decision	Acid-base characteristics will be evaluated using ABA analysis. Leachable metals (and other constituents) will be determined by the Nevada MWMP column method.	

TABLE B.4
DATA QUALITY OBJECTIVES

Task	DQO Step	Investigation Statement	Work Plan Reference
	Define the Study Boundaries	The study boundaries are the waste rock piles at the Crown Prince and Jones-Kincaid mine adits in Perry Canyon.	
	Develop a Decision Rule	If the data indicate that the waste rock is acid producing and release significant concentrations of metals, then the waste rock will be considered a potential source. The characteristics identified as a result of the data collection will be evaluated with the other site data, to provide overall site characterization and help prioritize potential remedial actions.	
	Specify the Limits on Decision Error	Limits on decision errors cannot be assessed for qualitative decisions that rely on the professional judgement of the field technician. Limits on analytical error are the internal laboratory DQOs.	
	Optimize the Decision	By collecting one composite sample (of 10 aliquots to one foot depth) from each waste rock pile, with one duplicate, a representative characterization of the waste rock properties is expected in the zone that is most likely acid producing and releasing metals. Sufficient data are expected to be generated to meet the DQOs.	
Efflorescent Mineral Evaluation	State the Problem	Efflorescent mineral salts have formed at locations where mine water discharges to Perry Canyon. Often these salts are metals salts that from during dry periods, and dissolve during storm events and result in significant storm water metals loading.	Section 4.3
	Identify the Decision	The analyses will be used to identify if the efflorescent minerals consist of elevated concentrations of metals.	
	Identify Inputs to the Decision	Total metals analyses will be conducted on composite samples.	
	Define the Study Boundaries	The study boundaries will be limited to the two locations where the minerals are formed at the Crown Prince adit and below the Jones-Kincaid adit.	
	Develop a Decision Rule	If elevated levels of metals are associated with the minerals, they will be considered a potential source of acid and metals.	
	Specify the Limits on Decision Error	Limits on analytical error are the internal laboratory DQOs including control limits for MS/MSD and LCS percent recovery, surrogate percent recovery and detection limits. The data quality goal is for characterization.	
	Optimize the Design	Composite samples will be collected to provide overall characterization of the minerals. Therefore, sufficient data are expected to be generated to meet the DQOs.	

Samples will be properly packaged in shipping containers to help ensure the integrity of the samples. Samples will be transported as soon as possible to the laboratory after sample collection. Shipping containers will be transported via courier or by priority next day delivery to the laboratory. Each shipment will be adequately tracked and documented and will arrive at the laboratory ready for analysis.

Each person who has the samples in his/her possession, including couriers (except Federal Express), will sign the COCR. Upon sample receipt at the laboratory, the cooler temperature will be recorded (if temperature is a preservation requirement) and the sample container integrity will be checked. Any deficiencies at the time of sample receipt at the laboratory will be documented on the cooler receipt form and the MWH Project QA Manager will be notified for necessary resolution.

1.2.2 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Instrument calibration is necessary to help ensure that the analytical systems are operating correctly and functioning at the proper sensitivity to meet Practical Quantitation Limits (PQLs). Calibration establishes the dynamic range of an instrument, establishes response factors to be used for quantitation, and demonstrates instrument sensitivity. All laboratory instruments will be calibrated in accordance with each laboratory's SOPs. Criteria for calibration are specific to the instrument and the analytical method. Field instruments will be calibrated daily or immediately before use, per manufacturer's instructions.

1.2.3 Inspection Requirements for Supplies and Consumables

All purchased supplies and consumables that support field monitoring and sampling activities or that have a direct relationship to sample quality (e.g. sample containers, decontamination supplies, distilled/de-ionized water) will be inspected upon receipt. At a minimum this inspection will check:

1) Part number/physical description matches requisition
2) Supplies are intact and undamaged
3) All required components/documentation is included

Any non-conforming items will be documented and returned to the supplier for replacement or other action as necessary.

1.3 DATA VALIDATION AND USABILITY

1.3.1 Data Review and Verification Requirements

The contracted laboratories will be responsible for reviewing all analytical data generated under this contract to help ensure that it meets the requirements of this QAPP. Each analyst reviews the quality of their work based on established protocols specified in laboratory SOPs, analytical method protocol, project-specific requirements and DQOs. The laboratory will provide analytical results in electronic and paper formats. At a minimum, data verification, to be conducted by MWH, will include evaluation of the analytical laboratory QC procedures, sampling documentation, technical holding time, instrument calibration, field and lab blank sample analyses, method QC sample results, field duplicates and the presence of any elevated detection limits.

1.3.1.1 Laboratory Quality Control

Laboratory overall method performance shall be monitored by the inclusion of various internal QC checks that allow an evaluation of method control (batch QC), and the effect of the sample matrix on the data being generated (matrix-specific QC). Batch QC is based on the analysis of a Laboratory

Control Sample (LCS) to generate accuracy (precision and bias) data and method blank data to assess the potential for cross-contamination. Matrix-specific QC will be based on the use of an actual environmental sample for precision and bias determinations from the analysis of Matrix Spike (MS), Matrix Spike Duplicate (MSD), matrix duplicates and surrogate spikes. Laboratory QC will be based on the labs internal QA/QC plan and SOPs. Some QC procedures discussed in this section are not included in the current scope, but are provided to cover future sampling scenarios. Current field QC requirements for the project were presented in Table B.1. The overall quality objectives are to implement procedures for laboratory analysis and reporting of data that are indicative of the degree of quality consistent with their intended use.

Method Blank Samples

Method blanks are analyzed to assess background interference or contamination that exists in the analytical system that might lead to the reporting of elevated concentration levels or false positive data. The method blank is defined as an interference-free blank matrix similar to the sample matrix to which all reagents are added in the same volumes or proportions as used in sample preparation and carried through the complete sample preparation, cleanup, and determinative procedures. For aqueous analyses, analyte-free reagent water would typically be used. The results of the method blank analysis are evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples. Sample results shall not be corrected for blank contamination.

In general, one method blank sample shall be analyzed for each analytical batch (one every 12 hours for GC/MS analyses). Contamination in method blanks (as well as reagent blanks, instrument blanks, extraction blanks for elutriations, initial calibration blanks, and continuing calibration blanks) above the Method Detection Limit (MDL) is not allowed. Data found to be associated with blanks containing target analytes at or above the MDL may be rejected with re-sampling and/or re-extraction and reanalysis at the expense of the laboratory. Chronic systematic method blank contamination will not be accepted.

Laboratory Control Samples

The LCS is analyzed to assess general method performance by the ability of the laboratory to successfully recover the target analytes from a control matrix. The LCS is similar in composition to the method blank. For aqueous analyses use analyte-free reagent water. For soil analyses, a purified solid matrix (e.g., Ottawa sand, sodium sulfate, or other purified solid) would typically be used. However, due to the difficulty in obtaining a solid matrix that is metals-free, analyte-free reagent water is taken through the appropriate digestion procedures for metals analyses. The LCS is spiked with all single-component target analytes (the complete target compound or analyte list) before it is carried through the preparation, cleanup, and determinative procedures. The laboratory will perform corrective action based on failure of any analyte in the spiking list. When samples are not subjected to a separate preparatory procedure the continuing calibration verification (CCV) may be used as the LCS, provided the CCV acceptance limits are used for evaluation. The spiking levels for the LCS would normally be set at the project-specific action limits assuming that the low standard used for the initial calibration was below this limit. If the low standard used was at this limit or if the site action levels were unknown, then the spiking levels would be set between the low and mid-level standards. The results of the LCS are evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples. The laboratory shall also maintain control charts, or tables for these samples to monitor the precision. The precision may be evaluated by comparing the results of the LCS from batch to batch, or by duplicate LCSs. Duplicate LCSs within the same batch are not required, but are recommended.

Matrix Spike

The MS is used to assess the performance of the method as applied to a particular project matrix. A MS is an environmental sample to which known concentrations of certain target analytes have been added before sample manipulation from the preparation, cleanup, and determinative procedures have been implemented. The entire target analyte list will be spiked within the MS. The laboratory will perform corrective action based on failure of any analyte in the spiking list. The spike concentrations of the target analytes would normally be set at the same level as the LCS. From the laboratory perspective, preparation batches require MS frequency at one per preparation batch. The merging of these MS frequencies is often difficult for the laboratory to implement. For instance, batches consisting of samples from multiple sites may require additional MSs to meet project requirements of evaluating the samples within the batch. For a MS from one site cannot be used to evaluate the matrix effects on samples from other sites. The results of the MS are evaluated, in conjunction with other QC information, to determine the effect of the matrix on the bias of the analysis. Sample results shall not be corrected for MS QC excursions.

Matrix Spike Duplicate

The MSD is used to assess the performance of the method as applied to a particular matrix and to provide information on the homogeneity of the matrix. A MSD is a duplicate of the MS as previously described. An MSD is an environmental sample that is either divided into two separate aliquots by the laboratory, or requires the submittal of an additional sample. When applicable, care should be taken to ensure that the sample is properly divided into homogeneous fractions. The MSDs are carried through the complete sample preparation, cleanup, and determinative procedures. The normal use of these QC samples would follow the same requirements as described for the MS. The MSD is included with each preparation batch of samples processed where target analytes were expected to be present (e.g., inorganic methods). An MSD is included with each preparation batch of samples processed where target analytes were not expected to be present (e.g., organic methods). The results of the MSD are evaluated, in conjunction with other QC information, to determine the effect of the matrix on the precision of the analysis.

1.3.1.2 Documentation and Records

MWH will store all important project-related records in a centralized and easily accessible project file. The project manager or designee will maintain the project file. The project file will include the following types of field records:

- Field data measurements
- Sample collection records
- COCRs
- QC sample records
- Field notes, which will include descriptions of any deviations from the QAPP and any difficulties encountered in maintenance or sample collection
- Data results from the analytical laboratories
- Laboratory data deliverables (hard copy and electronic)

All laboratory-related documentation and records will be controlled, distributed, stored and maintained by the contracted laboratories. The information and records to be included in project-specific data reporting packages, and the reporting format, are specified in the following sections.

1.3.1.3 Analytical/Statistical/Control Parameters

Precision

Precision refers to the distribution of a set of reported values about the mean, or the closeness of agreement between individual test results obtained under prescribed conditions. Precision reflects the random error and may be affected by systematic error. Precision also characterized the natural variation of the matrix and how the contamination exists or varies within that matrix. In order to assess matrix heterogeneity or sample handling procedures, field precision is commonly determined from field duplicates samples. In general, field duplicates (QC samples) will be collected at a frequency of one duplicate for each ten samples of a given matrix. The current field duplicate schedule was presented in Table B.1. The identity of QC samples shall be held blind to the Contract Laboratory until after analyses have been completed.

The relative percent difference for field and laboratory duplicates shall be calculated and used as a measure of precision, however only laboratory duplicates will be included in the quantitative assessment of completeness. Results of field duplicates will be described in qualitative assessment of completeness.

For environmental samples, laboratory precision is commonly determined from laboratory duplicate samples. Laboratory duplicates are defined as two aliquots obtained from the same sample which are extracted and analyzed for the purpose of determining matrix specific precision. In general, laboratory duplicates will be performed for all metals analyses at a rate of one in twenty (one for each batch up to a maximum of twenty). Precision for organic analyses may be determined by the analysis of MS/MSD samples.

Laboratory duplicate samples not meeting QC criteria shall be re-extracted/reanalyzed once. (For organic analyses failure of different matrix spike compounds to meet QC criteria on successive runs shall constitute failure and satisfy the requirement for reanalysis.) Statistical measures of precision included relative percent difference, standard deviation, or relative standard deviation.

Accuracy

Accuracy is the measure of the closeness of an observed value to the "true" value (e.g., theoretical or reference value). Accuracy includes a combination of random error and systematic error (bias) components that result from sampling and analytical operations.

Representativeness

Representativeness refers to the degree to which sample data accurately and precisely describe the characteristics of a population of samples, parameter variations at a sampling point, or environmental condition. Samples that are not properly collected or preserved (e.g., contaminant loss or addition) or are analyzed beyond acceptable holding times should not be considered to provide representative data. An assessment of represenativeness would include an evaluation of precision. The representativeness criterion is best satisfied in the laboratory by making certain that all subsamples taken from a given sample are representative of the sample as a whole. This would include sample pre-mixing/homogenizing prior to and during aliquotting procedures. Samples requiring volatiles analysis should not undergo any premixing or homogenization. Therefore, noting sampling characteristics in a case narrative may assist in the evaluation of data. Representativeness can be assessed by a review of the precision obtained form the field and laboratory duplicate samples. In this way, they provide both precision and representativeness information.

Comparability

Comparability is a qualitative objective of the data, expressing the confidence with which one data set can be compared with another. Sample data should be comparable for similar samples and sample conditions. Comparability is unknown unless precision and bias are provided. When this information is available, the data sets can be compared with confidence.

The laboratory shall make the necessary provisions to ensure the comparability of all data. These procedures include, but are not limited to, the use of standard approved methodologies, the use of standard units and report format, the use of calculations as referenced in the methodology for quantitation, and the use of standard measures of accuracy and precision for QC samples. All provisions to ensure data comparability shall be detailed in the QAPP.

Completeness

Completeness shall be evaluated qualitatively and quantitatively. The qualitative evaluation of completeness shall be determined as a function of all events contributing to the sampling event including items such as correct handling of chain of custody forms, etc. The quantitative description of completeness shall be defined as the percentage of measurements that are judged to be usable (i.e., which meet project-specific requirements) compared to the total number of measurements planned.

Sensitivity

The term sensitivity is used broadly here to describe the contract method detection, quantitation, and reporting limits established to meet the DQOs; and not limited to the definition which describes the capability of a method or instrument to discriminate between measurement responses. Several limits may be established to describe sensitivity requirements (i.e., instrument detection limits [IDL], MDL, sample quantitation limit [SQL], practical quantitation limits [PQL], contractor-required detection limits [CRDL], contract-required quantitation limits [CRQL], etc.). Current sensitivity requirements (MDLs) for this project are presented in the FSP.

1.3.2 Quality Control Responsibilities

All of the selected staff for this project have the qualifications and experience required for conducting their specific assignments. If staff changes are necessary during the execution of this work, resumes shall be submitted for new personnel, and a description of their responsibilities, in a technical memorandum to the USACE Project Manager. All MWH project personnel are responsible for identifying, reporting, and documenting any activities that could adversely affect the quality requirements set forth by the contract.

Each laboratory has a designated project manager for this project and shall provide direct interface with MWH personnel. As the Laboratory Project Manager, they are responsible for ensuring that all analytical data generated under this contract are reviewed prior to their release to MWH and the USACE Project Manager. They have sufficient authority to assure that samples submitted from the project site are received and processed in accordance with their MWH accepted quality management system.

1.3.3 Reconciliation with Data Quality Objectives

An assessment of data quality will be performed to determine whether data generated are consistent with the investigation objectives. If data are found to deviate significantly (several orders of magnitude) from previous analyses or surrounding conditions upon which the sampling program was based, the data may be qualified based on the validator's assessment of the usability of the data for the intended end uses.

1.4 CORRECTIVE ACTION

Corrective action is required when potential or existing conditions are identified that may have an adverse impact on data quality. Corrective action applies to both the field and laboratory procedures. In general, any member of the project team who identifies a condition adversely affecting quality can initiate corrective action. Written evidence (e.g. field or laboratory logbook) will document and identify the condition and explain the way it may affect data quality.

A well-defined and effective policy for correcting quality problems is critical to the success of a quality assurance program. While this QA program is designed to minimize problems, it must also identify and correct any problems that do exist. The corrective action system for this project will include:

- Identify the problem
- Identify cause of the problem
- Identify corrective actions to correct the problem
- Implement corrective actions
- Verify effectiveness of corrective actions in correcting the problem
- Document corrective action including:
  - Problem identified and cause
  - Corrective actions implemented
  - Effectiveness of corrective actions
  - Samples impacted by problem

Documentation of corrective actions will be included in the project file.

APPENDIX C

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX C

SITE SPECIFIC HEALTH AND SAFETY PLAN

PERRY CANYON SITE INVESTIGATION
USACE CONTRACT NO. DACW45-03-D-0001

August 2003

SITE SPECIFIC HEALTH AND SAFETY PLAN

for the
Perry Canyon Site Characterization Project
near Sutcliffe, Nevada

1.0 ITEMS 1.0 – 9.0 TO BE COMPLETED BY PROJECT MANAGER OR SITE SAFETY COORDINATOR:

PROJECT NAME: Perry Canyon Site Characterization Project

REQUESTED BY: Cary Foulk

PROPOSED START-UP DATE: September 1, 2003

PROJECT/TASK NUMBER: 1003797.011601

REVISION NUMBER 0

Prepared by/Reviewed by Health and Safety Coordinator

Printed Name: Mike Ross

Signature____ Date____________________

Approved by Project Manager

Printed Name: Cary Foulk

Signature____ Date____________________

2.0 PROJECT DESCRIPTION: The Perry Canyon site Work Plan consists of data collection activities associated with characterization of the site. The role of MWH at the site during activities will include project management, engineering, water and soil sampling and environmental monitoring.

3.0 LOCATION: The Perry Canyon site is located in Washoe County, approximately 30 miles north of Sparks, Nevada near the small town of Sutcliffe. The site is located in the northern portion of the Pah Rah Mountains southwest of Pyramid Lake. The site is accessed via State Highway 445 through Mullen Pass.

4.0 FACILITY/WORK SITE DESCRIPTION: The Perry Canyon site consists of several historic abandoned mine sites. Two mine sites, the Jones-Kincaid and Crown Prince, are the primary focus of the characterization.

5.0 PERSONNEL AND TASKS:

Project Manager: Cary Foulk

Field Personnel: Pam Anderson, Field Geologist

On-site Safety Coordinator: Pam Anderson

All personnel will be required to have a site briefing prior to first entry onto site. This briefing will be conducted by the MWH Site Health and Safety Coordinator or Project Manager. Additionally, "tailgate" safety meetings will be conducted daily prior to any activities. All field personnel will be OSHA 40 hour health and safety trained.

All contractors to MWH, and their subcontractors, are required to have their own individual site-specific Health and Safety Plans, which will be reviewed and approved by the MWH Site Safety Coordinator prior to mobilization on site.

6.0 EMERGENCY RESPONSE

The on-site safety coordinator will have final authority for first response to on-site emergency situations. In the event that the on-site safety coordinator is not on site, and alternate coordinator will be designated with all applicable authority.

Upon arrival of the appropriate emergency response personnel, the site emergency coordinator shall defer all authority to emergency response personnel but will remain on the scene, if necessary, to provide any and all possible assistance. At the earliest opportunity, the site safety officer or the site emergency coordinator shall contact the MWH Project Manager or MWH Health and Safety Officer.

Project Manager:
Cary Foulk **Phone (W) :** (970) 879-6260 **Phone (H) :** (970) 871-1734
Mobile Phone: (303) 949-3275

Health & Safety Officer:
Mike Ross **Phone (W) :** (970) 879-6260 **Phone (H) :** (970) 638-1088

Nearest Emergency Facility: Tahoe Pacific Hospital

Location: Sparks, Nevada

Telephone: (775) 331-1044

Directions: Follow Highway 445 from Mullen Pass to Sparks, NV. Highway 445 becomes Pyramid Way. Turn left off of Pyramid Way onto Prater Way. Follow Prater Way approximately 4 miles to end of street and hospital.

7.0 DETAILED WORK DESCRIPTION

The Perry Canyon Work Plan consists of sampling and characterization activities associated with the evaluation of possible water quality impacts. The role of MWH at the site during the site activities will include project management, soil and water sampling, engineering design conceptualization, and environmental monitoring and testing. The work will be conducted at various locations on the site including the waste rock piles, flowing adits and groundwater monitoring locations.

Site activities will include the following tasks:

- Groundwater and surface water sampling;
- Waste rock sampling; and,
- Sampling of evaporative minerals.

8.0 CHEMICAL/RADIOLOGICAL HAZARD EVALUATION

Are chemicals or radiological hazards known or suspected at this site.

_X_ Yes - describe below ___ No

	Waste Media		Hazardous Characteristics
___	Airborne Contamination (dust)	__	Ignitable
X	Surface Contamination	X	Corrosive
X	Contaminated Soil (metals)	__	Reactive
X	Contaminated Groundwater	__	Explosive
X	Contaminated Surface Water	X	Toxic (non-radiological)
X	Solid Waste	X	Radioactive
___	Liquid Waste		

Description:

PRIMARY HAZARDS (Rate: low, medium, high, extreme)								
Substance	**Inhalation of Gases/ Vapors**	**Inhalation of Dusts/ Mists**	**Ingestion**	**Dermal Absorption of Solids/Liquids and or Skin Contamination**	**Dermal Absorption of Gases/ Vapors**	**Corrosive/ Irritant**	**Ignitability**	**Toxicity**
Waste Rock	N/A	LOW	LOW	LOW	N/A	LOW	N/A	LOW
Low pH water (< 3.0 pH)	N/A	N/A	LOW	LOW	N/A	LOW	N/A	LOW

9.0 PERSONAL PROTECTIVE EQUIPMENT

Location	Job Function/Task	Initial Level of Protection			
		A	B	C	D
Perry Canyon Site	Soil Sampling, Site Characterization				X
Perry Canyon Site	Groundwater and surface water sampling				X

List the specific protective equipment and material (where applicable) for each of the Levels of Protection identified above.

Level C (same as Level B with lower level respiratory protection)

- Coveralls
- Disposable nitrile
- Chemical resistant clothing, gloves and boots
- Long underwear
- Ear Protection
- Half or full face air purifying respirator with canister
- Canister type: _____ HEPA, _________ (Other)
- Hard hat, steel toed rubber boots, safety glasses
- Inner latex gloves
- Outer NBR (Nitrile Butyl Rubber) gloves
- Tyvex if waste is dry. Polytyvek if wet. Saranex if PCB wastes.
- Two-way radio communication

Level D (modified)

X Coveralls (as required)
X Standard work clothes
__ Hard hat
X Safety boots
X Safety glasses
X Goggles (as needed during water sampling)
X Acid resistant gloves (when sampling low pH water)
__ Safety vest (as required when around heavy equipment)
__ Ear protection
__ Dust mask (required during dusty conditions)

NO CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL BE MADE WITHOUT THE KNOWLEDGE AND APPROVAL OF THE HEALTH AND SAFETY OFFICER AND THE PROJECT MANAGER.

10. ACTION LEVELS

Task personnel shall observe the following Action Levels:

Substance	Action Level	Specific Action
Acid Water Sample	pH < 3.0	Skin Protection – Chemical resistant gloves, chemical resistant safety glasses.

11. CONFINED ENTRY PROCEDURES X Not Applicable __ Applicable

Will this project require entry into any confined or partially confined space?

__ Yes - describe below X No - abandoned mines may constitute a confined space but will not be entered under any circumstance.

It is not anticipated that any reclamation tasks will involve working in a confined space. If confined spaces are encountered work will be done in accordance with the MWH corporate confined space entry procedures.

12. CUTTING/WELDING PROCEDURES X Not Applicable __ Applicable

Will any task involve use of a cutting torch or welding?

__ Yes - describe below X No

Requirements

__ Relocate or Protect Combustibles
__ Wet Down or Cover Combustible Floor
__ Check Flammable Gas Concentrations (% LEL) in air
__ Cover Wall, Floor, Duct and Tank Openings
__ Provide Fire Extinguisher

13. OTHER POTENTIAL HAZARDS

__	Fire/Explosion	X	Trips, Slips, Falls
X	Temperature Stress	___	Trenching/Shoring
___	Electrical	X	Vehicular Traffic
___	Gas (Sulfur, O_2 deficiencies)	___	Overhead Hazards
X	Unstable/Uneven Terrain	___	Machinery/Mechanical Equipment
___	Torch Cutting or Welding	X	Other - Describe below

Description:

- Site location is subject to hot and cold weather extremes. Cold exposure may increase with wind velocity. Weather conditions have the potential become extreme rather quickly (rain or snow). Cold weather and rain gear should be available at the site at all times. Site personnel should be aware of heat stroke potential, and monitor as appropriate during warm weather activities.

- Personnel need to be aware of unmarked hazards which may potentially cause slips, trips, and falls. These unmarked hazards may include unstable or uneven terrain, miscellaneous site debris, piping, cables, low profile concrete building foundations, etc.

- Historic abandoned mines are located on the site. Caution will be employed around any of the historic structures or mine openings. Such features may be unstable. Mine openings may be unstable and the mines may contain oxygen deficient atmosphere, hide hazardous conditions or animals. Under no conditions will the abandon mines be entered.

? Other potential site hazards include the presence of poisonous snakes, insects and other wildlife (i.e., bears)

An activity hazard analysis (AHA) of site sampling activities is presented in Table 1 at the end of this Health & Safety Plan.

14. PERSONAL MONITORING X Not Applicable __ Applicable

__ Passive Dosimeter __ Biological Monitoring __ Personal Air Sampling __ Other

Does this project require medical surveillance or biological monitoring procedures beyond the provisions of the routine medical surveillance program? ___ Yes X No

If yes, describe below.

Description: N/A

15. PERSONAL DECONTAMINATION X Not Applicable ___ Applicable

ON-SITE CONTROL X Not Applicable ___ Applicable

At this time, contamination above any action levels is not expected in any of the areas where sampling is planned. Therefore, a Controlled Zone has not been established. If a Controlled Zone is established, personnel and equipment leaving the Controlled Zone shall proceed through the following decontamination stations and procedures from the decontamination zone (Decontamination area(s) designated for all decontamination activities, will be selected by MWH field supervisors):

A: Personnel Decontamination

(Procedure not required unless action level utilizes Level C PPE or higher.)

Station Procedure

1. Boot wash	Wash (scrub) and rinse steel toed rubber boots
2. Outer glove wash/drop	Wash and rinse outer rubber gloves
3. Respirator	Remove respirator - wash nightly

Emergency Decontamination Procedures:

If decontamination can be done: Wash, rinse and/or cut off protective clothing and equipment.

If decontamination cannot be done: Wrap victim in blankets, plastic or rubber to reduce contamination of other personnel. Alert emergency and off-site personnel to potential contamination; instruct them about specific decontamination procedures if necessary. Send along site personnel familiar with the incident.

The following decontamination equipment is required:

NONE

SANITATION REQUIREMENTS (May be clarified during future site visit.)

Potable water supply (portable water cooler) available on work site? _X_ Yes __ No

Portable toilets required on work site? __ Yes _X_ No

Temporary washing/shower facilities required at work site?
___ Yes If yes, describe below.
_X_ No If no, state location of existing facilities. Sparks, Nevada

16. EMERGENCY PROCEDURES This section to be in on-site field vehicles.

EMERGENCY RESPONSE

The on-site safety coordinator, Pam Anderson, has final authority for first response to on-site emergency situations. In the event that the on-site safety coordinator is not available, an alternate coordinator will be designated with all applicable authority.

Nearest Emergency Facility: __________________

Location: Sparks, Nevada

Telephone: ____________________

Directions: ______________________________

Upon arrival of the appropriate emergency response personnel, the site emergency coordinator shall defer all authority but shall remain on the scene, if necessary, to provide any and all possible assistance. At the earliest opportunity, the site safety officer or the site emergency coordinator shall contact the MWH Project Manager or Health and Safety Officer.

Project Manager:
Cary Foulk **Phone (W) :** (970) 879-6260 **Phone (H) :** (970) 871-1734
Mobile Phone : (303) 949-3275

Health & Safety Officer:
Mike Ross **Phone (W) :** (970) 879-6260 **Phone (H) :** (970) 638-1088

On-site Communication Required? __ Yes _X_ No

On-site: N/A

Emergency Channel: N/A

Nearest Telephone: Mobile phone or public phone at store on Mullen Pass road (between Perry Canyon and Pyramid Lake.

Mobile Telephone (site): Limited cellular service in area.

FIRE AND EXPLOSION

In the event of a fire or explosion, if the situation can be readily controlled with available resources without jeopardizing the health and safety of yourself, the public, or other site personnel, take immediate action to do so, otherwise:

1. Notify emergency personnel by calling 911
2. If possible, isolate the fire to prevent spreading.
3. Evacuate the area.

EXPOSURE

Site workers must notify the site Health and Safety Officer immediately in the event of any injury or any of the signs or symptoms of overexposure to heat or cold.

Designated Personnel Current in First Aid/CPR: (TBD)

REQUIRED EMERGENCY BACK-UP EQUIPMENT/NOTIFICATIONS:
(Located in back of field vehicle.)

_X_ Fire extinguisher
_X_ First aid kit, including eye wash
_X_ Portable phone
___ Radio
_X_ Flares
_X_ Water in field vehicles, including ample volume for possible rinsing
_X_ Hearing protection
_X_ Dust masks
_X_ Rain and cold weather gear
_X_ Buddy System – make sure someone else knows where you are and your schedule

17. FIELD PROCEDURES CHANGE AUTHORIZATION

Instruction Number to be changed:
Duration of Authorization Requested:

Date:

Description of Procedure Modification:

Justification:

Person Requesting Change:	**Verbal Authorization Received From:**
______________________	______________________
Name	Name
______________________	______________________
Title	Title
______________________	______________________
Signature Date	Approved By Date

(Signature of person named above to be obtained within 48 hours of verbal authorization)

18. SAFETY BRIEFING

The following safety briefing will be completed each day prior to commencement of site activities:

The following personnel were present at pre-job safety briefing conducted at ____________(time), on___ ___________(date) at__________________________________ (location) and have read the above plan and are familiar with its provisions:

The personnel whose signatures appear below were in attendance at said briefing and are familiar with the provisions of this Health and Safety Plan:

Name	Signature
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Fully charged ABC Class fire extinguisher available at work site? Yes __
Fully stocked first aid kit available on site? Yes __
All project personnel advised of location of nearest phone? Yes __

All project personnel advised of location of designated medical facility or facilities? Yes __

____

Printed Name of Project Manager or Site Safety Officer

____

Signature and Date

A copy of this form is attached at the end of this document.

TABLE 1
ACTIVITY HAZARD ANALYSIS FORM

Perry Canyon Site

ACTIVITY: Waste Rock and Mineral Sampling **ANALYZED BY/DATE:** Mike Ross, **REVIEWED BY/DATE:**

Principal Steps	Potential Hazards	Recommended Controls
Identify the principal steps involved, including the equipment and machinery to be used, and the sequence of work activities	Analyze each principal step for its potential chemical/ toxicological, radiological, biological and physical hazards	Develop specific controls for each potential hazard. Also: • List inspection requirements for the equipment / machinery listed • Specify worker training requirements
• Use a shovel, trowel or hand auger to remove sample material from ground • Contain soil in jar or plastic bag • Prepare soil samples at a portable table or on tailgate of truck (note: surface that is used must be covered with a tarp or plastic to prevent spread of contamination).	Chemical/Toxicological Hazards: Chemical exposure hazards are listed in Section 8.0 Radiological Hazards: No radiological hazards are anticipated Biological Hazards: 1. Possible biological hazard from spiders, mosquitoes or snakes Physical Hazards: 1. Slip/trip/fall on uneven terrain 2. Thermal stress (hot or cold) 3. Blisters from hand tools 4. Lifting heavy objects	Chemical/Toxicological Hazards: 1. Air monitoring is not required for this task. 2. Level D PPE as initial level, see Section 9.0 Radiological Hazards: No radiological hazards are anticipated Biological Hazards: 1. Use Level D PPE to protect against skin contact with poisonous spiders 2. Watch your step. 3. After and during the field effort, check for ticks in hair and on exposed skin Physical Hazards: 1. Watch where you step, be aware that sticks, rocks or other items can be concealed by leaves and grass, causing you to trip. 2. Refer to Section 13.0 for a discussion on heat/cold stress and severe weather. Wear appropriate clothing and keep hydrated. If weather conditions are dangerous, postpone field work 3. When lifting use the legs to support the weight, instead of the back. Bend at the knees and get a good grasp of the material. If it is awkward or heavy, get help! 4. Wear heavy work gloves when handling hand augers or other objects with sharp edges.

TABLE 1
ACTIVITY HAZARD ANALYSIS FORM

Perry Canyon Site

ACTIVITY: Water Sampling **ANALYZED BY/DATE:** Mike Ross, 7-9-02 **REVIEWED BY/DATE:**

Principal Steps	Potential Hazards	Recommended Controls
Identify the principal steps involved, including the equipment and machinery to be used, and the sequence of work activities	Analyze each principal step for its potential chemical/ toxicological, radiological, biological and physical hazards	Develop specific controls for each potential hazard. Also: • List inspection requirements for the equipment / machinery listed • Specify worker training requirements
1. Spring sampling involves walking to the sampling location, kneeling down and collecting water in the sampling device. 2. Well monitoring involves opening the well top, purging a set amount of volume from the well, collecting water quality parameters like temperature, pH and electrical conductivity by putting water in a jar and testing with the appropriate meter, then opening the sample containers and bailing water into the containers. 3. Recording elevation measurements involves opening wells and sending a measuring tape devices down hole and logging the information.	Chemical/Toxicological Hazards: Chemical exposure hazards are listed in Section 8.0 Radiological Hazards: No radiological hazards are anticipated Biological Hazards: 1. Possible biological hazard from spiders or snakes Physical Hazards: 1. Slip/trip/fall on uneven terrain 2. Thermal stress (hot or cold) 3. Lifting heavy objects 4. Prolonged static posture – standing while well is purging or when pouring water into sampling containers	Chemical/Toxicological Hazards: 1. Air monitoring is not required for this task. 2. Level D PPE as initial level, see Section 9.0. Use an apron if necessary to avoid splash. PVC or rubber knee height boots may be needed for spring sampling. Radiological Hazards: Radiological hazards are not anticipated Biological Hazards: 1. Use Level D PPE to protect against skin contact with poisonous spiders, caution should be used when opening well covers that may house insects. 2. Watch your step. 3. After and during the field effort, check for ticks in hair and on exposed skin Physical Hazards: 1. Watch where you step, be aware that sticks, rocks or other items can be concealed by leaves and grass, causing you to trip. 2. Refer to the APP Section 13.0 for a discussion on heat/cold stress and severe weather. Wear appropriate clothing and keep hydrated. If weather conditions are dangerous, postpone field work 3. When lifting use the legs to support the weight, instead of the back. Bend at the knees and get a good grasp of the material. If it is awkward or heavy, get help! 4. Wear heavy work gloves when handling well caps, especially those that may be flush mounted to the ground. 5. Avoid standing or stooping in one place for long periods of time. Take breaks to stretch or pull up a bucket to sit on.

ATTACHMENT

SAFETY BRIEFING FORM

SAFETY BRIEFING FORM

The following safety briefing will be completed each day prior to commencement of site activities:

The following personnel were present at pre-job safety briefing conducted at ____________(time), on___ ___________(date) at________________________________ (location) and have read the above plan and are familiar with its provisions:

The personnel whose signatures appear below were in attendance at said briefing and are familiar with the provisions of this Health and Safety Plan:

Name	Signature
________________________	________________________
________________________	________________________
________________________	________________________
________________________	________________________
________________________	________________________

Fully charged ABC Class fire extinguisher available at work site?	Yes __
Fully stocked first aid kit available on site?	Yes __
All project personnel advised of location of nearest phone?	Yes __
All project personnel advised of location of designated medical facility or facilities?	Yes __

____

Printed Name of Project Manager or Site Safety Officer

____

Signature and Date

APPENDIX D

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE

SOP-1
COLLECTION OF SURFACE WATER QUALITY SAMPLES

TABLE OF CONTENTS

Section No. **Page No.**

1.0 INTRODUCTION

This standard operating procedure (SOP) describes methods and equipment commonly used for collecting environmental samples of surface water for either on-site examination and chemical testing or for laboratory analysis. It also describes procedures for sample handling, labeling and documentation.

The information presented in this SOP is generally applicable to all environmental sampling of surface waters except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions, and equipment different from those described herein.

This document describes multiple methods and a variety of equipment. The appropriate methods and equipment selected will be based on the project specific sampling and analysis plan and site conditions. Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Every field investigation must be conducted in accordance with an approved quality assurance project plan (QAPP). The QAPP identifies the minimum procedures required to assure that goals for precision, accuracy, completeness, representativeness, and comparability of data generated are satisfied. In addition to the QAPP, every field program must have a site-specific field sampling plan (FSP) that defines the proper procedures to be followed in the collection, preservation, identification and documentation of environmental samples and field data.

The same care must be exercised in implementing field investigations and sampling programs that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)
- U.S. Department of the Interior, Geological Survey (USGS)

2.0 DEFINITIONS

Bailer: A long narrow tubular device with an open top and a check valve at the bottom. Bailers may be made of Teflon®, Polyethylene, or stainless steel.

Conductivity: The ability of a solution to conduct electricity.

Dip Sampler: A sample container that may be held directly or attached to a pole, used to collect surface water samples from the surface or just beneath the surface.

Dissolved Oxygen (DO): A measure of the quantity of oxygen dissolved in a water body. DO data is collected in the field using direct measurement probes.

Environmental Sample: A solid or liquid sample collected for chemical or physical analysis. These samples are used to support remedial investigation, feasibility studies, treatability studies, remediation design and performance assessment, and waste characterization.

Peristaltic Pump: A low volume pump that operates by suction lift.

pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity to a maximum value of 14, and decreasing with increasing acidity.

Splitter container: A container that is used for compositing surface water sub-samples, from which are drawn or transferred sample aliquots that are submitted for laboratory analysis.

Temperature: A measure of the thermal energy contained in a given system. Units are commonly in degrees Centigrade (°C) or Fahrenheit (°F).

Turbidity: Cloudiness in water due to suspended and colloidal organic and inorganic material.

3.0 SAMPLING PROCEDURES

3.1 BACKGROUND

Collecting a representative sample from surface water is often difficult because of water movement or stratification. To collect representative samples, sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification must be minimized.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important element not only for assessment and quantification of environmental impact to, or posed by, the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a representative sample has been taken.

3.2 DEFINING THE SAMPLING PROGRAM

Factors that will be considered in developing a sampling program for surface water include study objectives; accessibility; site topography; flow, mixing, and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the investigation(s). For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. The hydrologist developing the sampling plan must therefore understand the mixing characteristics of streams, lakes, ponds, and lagoons.

3.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the quality of the surface water entering, leaving, or remaining within the site. The scope of the sampling program will therefore consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky evaporation ponds, outfalls, etc.) or non-point sources (e.g., runoff from tailings piles). The major pathways for surface water contamination (not including airborne deposition) are:

- Overland runoff
- Leachate influx to the water body
- Direct waste disposal (solid or liquid) into the water body
- Up-gradient groundwater influx

The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) that encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction; areas of temporary flooding or pooling; artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation); and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, etc., will not be overlooked.

The potential for dispersion of dissolved or sediment-associated contaminants away from the source will also be considered. The dispersion may lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations.

The distribution of particulates within a sample is an important consideration. Many organic compounds are only slightly water-soluble and tend to be adsorbed by particulate matter. Nitrogen, phosphorus, and heavy metals may also be transported by particulates. Surface water samples will be collected with a representative amount of suspended material.

The following factors will be considered in selecting sampling locations:

- site history
- hydrologic boundaries and features of the site
- sources, pathways and potential distribution of contaminants

Based on these considerations the numbers, types, and general locations of required samples up-gradient (for background measurement), on site, and down-gradient can be identified.

3.2.2 Locating Sampling Stations

Accessibility is a key factor affecting sampling costs. The utility of a sample for analysis and characterization of site conditions will be weighed against the costs of collection as controlled by accessibility. Wherever possible, bridges will be used to access sampling stations on streams because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or canoe may also be used to sample locations on lakes and ponds.

Wading is another technique that can be used to obtain a sample. When wading, the sampler must be careful to minimize disturbance of bottom sediments. The stream should be entered downstream of the sampling location. If necessary, the sampling technician will wait for the sediments to settle before taking a sample.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to assure, as closely as possible, that samples are taken where uniform flow and good mixing conditions exist.

Streamflow records can be useful in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gauging station is not conveniently located on a selected stream, the project hydrologist will explore the possibility of obtaining streamflow data by direct or indirect methods. Surface water flow rate measurement procedures are presented in SOP-3.

3.2.3 Sampling Frequency

The sampling frequency and the objectives of the sampling program will be defined by the project-specific work plan. For single-event site- or area-characterization sampling, water samples will be collected at the specified sampling locations. If samples are collected primarily for monitoring purposes, such as to define variations and trends at a given location, samples will be collected at a pre-established and consistent intervals as specified in the project-specific work plan (often monthly or quarterly) and during droughts and floods.

The variability in available water-quality data will be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program. For storm event samples, a record of rainfall intensity over the duration of the storm will be obtained.

3.3 SAMPLE COLLECTION THEORETICAL CONSIDERATIONS

3.3.1 Streams, Rivers, Outfalls, and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls, and drainage features at a single point vary from simple hand-sampling procedures to the more sophisticated multi-point sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (defined below).

Samples from different depths or cross-sectional locations in the watercourse taken during the same sampling episode will be composited. However, samples collected along the length of the watercourse or collected at different times may reflect differing inputs or dilutions and therefore will not be composited. Generally, the number and type of samples to be taken will depend upon the width and depth of the course, discharge, and the suspended sediment load. The greater the number of individual points that are sampled, the more likely that the composite sample truly will represent the overall characteristics of the water.

In small streams less than about 12-feet wide, a sampling site can generally be located where the water is well mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross section.

For larger streams, at least one vertical composite will be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of water quality parameters of pH, temperature, and conductivity will be made, as specified in the Work Plan, on the composite itself. For rivers, it may be necessary to collect several vertical composites.

3.3.2 Lakes, Ponds, and Reservoirs

Lakes, ponds, and reservoirs have a much greater tendency to stratify than rivers and streams do. The relative lack of mixing requires that a high number of samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of water quality parameters of pH, temperature, and conductivity should be conducted on each aliquot of the vertical composite. In naturally formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites will be composited to form a single sample. These verticals are often taken along a transect or grid. Normally, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately characterize water quality due to the likely existence of poor mixing conditions in these areas. Similarly, additional samples will be taken where discharges, tributaries, land-use characteristics, and other such factors are likely to influence water quality.

3.3.3 Seeps and Springs

Sampling equipment and procedures for seep and spring sampling will be based on site conditions. Samples will generally be collected by compositing subsamples into a splitter container, and then transferring the sample aliquots into the sample bottles. Collection procedures may be accomplished as follows.

- By digging a small hole in the seep and allowing it to fill with water for transfer to the splitter container. A high density polyethylene (HDPE) beaker is used to transfer the subsample aliquot from the depression to the splitter container. This procedure is used particularly in situations where there is insufficient free water for sampling.

Samples may be collected both at the point of discharge and along any overland flow. Specific sample collection locations will be included in the project-specific work plan. The list below provides a summary of sampling equipment and related procedures.

- Trowel and Beaker - dig a small hole in the seep, place the HDPE beaker in the hole, and allow it to fill with water for transfer to sample container

- Disposable bailer - collect water directly from source with a disposable bailer and transfer to splitter container

Transfer from sampling equipment to sample containers should be done in such a manner as to minimize sample aeration and turbulence.

3.4 SAMPLE COLLECTION

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube or bailer
- Dip sampler
- Weighted bottle sampler
- Peristaltic pump
- Hand pump

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Ease of disposal and, or decontamination.

- Relative expense (if the item is to be disposed of).

- Ease of operation, particularly if personnel protection required is above Level D.

- Reactivity/contaminating potential - Teflon-coated, glass, stainless steel, or Polyethylene sample chambers are preferred (in that order).

Each sample (grab or each aliquot collected for compositing) will be measured for the project specific water quality parameters (e.g., pH, DO, temperature, specific conductance, and turbidity). Field water quality measurements will be made by placing the meter probe directly into flowing water, whenever possible. If an in-situ measurement is not possible, then the measurements will be made streamside using a decontaminated HDPE beaker, or equivalent.

These parameters will be measured and recorded as soon as the sample is recovered. Other important indicator parameters include biological oxygen demand (BOD), chemical oxygen demand (COD), total organic content (TOC), total solids (TS), alkalinity, hardness, and major ion chemistry.

Analysis of these parameters provides information on water mixing/stratification and potential contamination, and will be based on the project-specific data quality objectives. Sample collection procedures are discussed below for three methods: direct collection, discrete-depth, and peristaltic pump.

3.4.1 Direct Collection

With this technique, surface water samples will be collected by filling a decontaminated container, either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Sample containers will be filled directly from the sample collection container, or most commonly, from the splitter container.

Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible dip samples will be augmented with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

3.4.2 Discrete-depth Collection

A sample can also be collected using a discrete-depth sampling. This instrument is lowered to a desired depth. A weighted-messenger is sent down the tether line and releases a spring mechanism that closes the sampler. This allows collection of a sample at a specific point in the vertical profile. Several of these samples can be combined to provide a vertical composite.

In using this method, a decontaminated sampler, such as a Kemmerer sampler, is lowered gently to the surface of the water and allowed to sink under its own weight to the desired depth. A nylon rope, or equivalent, is used to lower the sampler to the desired depth . Once the sampler reaches the desired depth, it should be moved back and forth gently to displace any water that may have entered the sampler as it was lowered from the surface. The messenger will trip the closure mechanism, trapping the water sample in the sampler. The sampler is then raised slowly to the surface and samples should be transferred to splitter container or directly into the sample bottles.

3.4.3 Peristaltic Pumps

Peristaltic pumps are low-volume pumps that operate by suction lift. These pumps require the use of flexible silicone tubing. The withdrawal rate can be regulated by adjusting the rotor head revolution. While using these pumps, the following procedures will be followed:

- Install clean silicone tubing
- Lower the pump intake to the desired depth and pump water at a rate of 100 ml/min or less
- Discharge water directly into sample containers with minimum turbulence by pouring down the side of the container

3.4.4 Hand Pumps

Hand pumps may operate by peristaltic, bellows, diaphragm, or siphon action. Hand pumps operate much the same way as do peristaltic pumps but utilize hand-cranked versus battery powered pumping.

3.4.5 Sample Filtration

Water samples collected for analysis of dissolved cations and trace metals will be field filtered, whenever possible. Sample filtration will be performed using a peristaltic pump, or hand pump and disposable 0.45 micron cartridge filters. Specific procedures for field filtration are outlined below.

1) A decontaminated HDPE transfer (splitter) container will be used to composite subsamples collected for filtration.

2) Rinse the splitter container a minimum of three times with sample water and then fill.

3) If the sample cannot be immediately filtered, label the transfer container with the site number and time of collection and take to the filtering station.

4) Set up the filtering station either by connecting the peristaltic pump to a battery or, by assembling the handheld vacuum apparatus.

5) Rinse the outside end of the pump tubing that will be placed in the transfer container with sample water from the transfer container. After rinsing, place the tubing in the transfer container.

6) Attach a <u>new</u> disposable cartridge filter to the other end of the pump tubing. It is imperative that a new filter be used for each sample.

7) Turn on the pump and pass a minimum of 250 ml of sample water through the tubing and cartridge filter before collecting the sample.

8) After rinsing the filter, proceed to fill up the proper sample container(s). Filtered water should be passed directly into the sample container from the outlet of the filter.

9) Note on the sample container label and chain of custody form that the dissolved cation/metals sample has been field filtered.

10) Disconnect the filter and tubing from the pump head and dispose.

11) Carefully store the pump in the carrying case to avoid contamination with dirt, etc.

Surface water samples will be filtered as soon as possible, although if field conditions make this impractical, these samples may be filtered within a few hours after collection.

3.4.6 Field Measurements

Dissolved oxygen, pH, specific conductivity, temperature, and turbidity will be measured in the field using hand-held portable meters. The field water quality measurements should be made by directly placing the probe of meter into flowing water whenever possible. If an in-situ measurement is not possible, then the measurements should be made streamside using a decontaminated HDPE beaker.

The field meter will be calibrated, at a minimum, at the beginning of each day's use and checked again at the end of the day. More frequent calibration and, or checks may be necessary if anomalous readings occur. Instructions provided by the equipment manufacturer will be followed to properly calibrate and operate the meter and all calibration results will be recorded in the field book.

Field measurement readings will be recorded in the field notebook and on the field data forms.

3.4.7 Decontamination of Field Equipment

The following water quality sampling equipment will require regular decontamination:

- Field water quality meter(s)
- Glass or plastic beakers used to transfer samples
- Peristaltic pump and tubing

The sample collection equipment will be decontaminated at each monitoring location. The following guidelines will be used to decontaminate sampling equipment:

- Gross contamination on equipment will be scraped off at the sampling site.

- Equipment that will not be damaged by water (water level meter probe and tape, pH/conductivity probe, dissolved oxygen probe, sample transfer containers) will be washed with the Alconox (or a comparable non-phosphate), biodegradable detergent. Equipment will be triple rinsed with potable water followed by a triple distilled or de-ionized water rinse.

- Equipment that may be damaged by water (portable meters) will be carefully wiped clean using a sponge and detergent water, and rinsed with distilled or de-ionized water. Care will be taken to prevent any equipment damage.

- All non-dedicated equipment will be decontaminated between each sample location. When purging groundwater monitoring wells, meter probes will be rinsed with distilled or de-ionized water between each casing volume measurement. After collecting the sample follow the full decontamination procedures.

- Rinse and detergent waters will be replaced with new solutions between sampling events.

Following decontamination, equipment will be placed in a clean area or in clean plastic bags to prevent contact with soils/sediments and airborne material that could contaminate a future sample.

4.0 SAMPLE HANDLING AND FIELD DOCUMENTATION

The purpose of this section is to define the standard protocols for sample handling, documentation and chain-of-custody. The use of proper documentation and chain-of-custody procedures will assure that the adequacy of the sample collection methods and handling can be evaluated.

4.1 SAMPLE HANDLING

4.1.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, sample bottles will be obtained directly from the analytical laboratory, or laboratory supply-house. The bottles will be labeled (see following section) to indicate the type of sample and sample matrix to be collected. Sample bottles can be either pre-preserved from the laboratory or preservatives can be added in the field during sample collection. In general, 0.5-liter or 1-liter polyethylene or glass bottles will be used for the sample bottles that will be submitted for analysis of general chemical constituents, major inorganic constituents and metals.

Laboratory sample containers will be filled one by one at the monitoring location, secured with the container lid, and any excess water wiped off the exterior. Immediately after collection, the containers will be placed in field coolers with ice. Glass containers will be wrapped with bubble wrap or other appropriate shipping material to prevent breakage.

4.1.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to assure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping.

For all samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

4.1.3 Sample Holding Times

Sample holding times are established to minimize chemical changes in a sample prior to analysis and, or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and, or extraction, based on the nature of the analyte of interest and chemical stability factors.

To meet recommended holding times, analytical samples will be shipped to the analytical laboratory in iced coolers as soon as possible or within 48 hours of collection, if conditions permit**.**

4.1.4 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described above, and placed on ice in an insulated cooler. The sample containers should be placed in re-sealable plastic storage bags. Samples should be stored in an upright position. A chain of custody form will be placed in a Ziploc™ bag inside the cooler. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to assure that the cooler cannot be opened without breaking the seal.

4.2 FIELD DOCUMENTATION

Documentation establishes procedures, identifies written records, enhances and facilitates sample tracking, standardizes data entries, and identifies and establishes authenticity of the sample data collected. Proper documentation also:

- Assures that all essential and required information is consistently acquired and preserved
- Documents timely, correct, and complete analysis
- Satisfies quality assurance requirements
- Establishes chain-of-custody
- Provides evidence for court proceedings
- Provides a basis for further sampling

4.2.1 Sample Labels

Samples collected will be identified by a sample tag attached to the sample bottle. A sample tag or label will be completed and attached to each laboratory sample container just before it is filled. The labels will be filled out with a permanent marker and will include the following information:

- Sample identification
- Sample date
- Sample time
- Sample preservative (if any)
- Sample type (including if raw or field filtered)

Because a variety of preservatives and analytical methods will be employed, care must be taken to avoid mislabeling the containers. If possible, labels should be covered with plastic tape to minimize smudging and ink runs.

4.2.2 Field Documentation

Appropriate field records will be completed in a bound field logbook and, or field data sheets at each site at the time of sample collection. Examples of field data sheets are found in Appendix C of the Water Monitoring Plan. All aspects of sample collection and handling as well as visual observations will be documented in the field logbooks. In general, field logbooks as well as field data records should:

- Record, identify and describe all pertinent sampling and monitoring activities.
- Record quantitative and qualitative information for each sample collected.
- Record and describe all field team activities, including observations and events.

At a minimum, the following information will be recorded in the field at each monitoring station:

- Site location
- Sampler name(s)
- Date and time of sample collection
- Sample identification number(s)
- Type of sample (stream, spring, groundwater, potable water)
- Field water quality measurements (pH, conductivity, temperature, turbidity, DO)
- Sample handling (including filtration and preservation, as appropriate)

- How sample collected (e.g. grab, composite, bailer)
- Number and type of any QA/QC samples collected
- Spring discharge or stream flow, including measurement method (if applicable)
- Weather conditions, including recent precipitation and approximate air temperature
- Field observations, including any unusual conditions or activities in the area

Changes or deletions in the field logbook or on field data forms (see Appendix D) should be lined out with a single strike mark and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory. All field notebooks and data forms will be signed at the end of each day.

4.2.3 Chain-of-Custody

A chain-of-custody (COC) record is used to record the custody and transfer of all samples. The field sampler will be responsible for the care and custody of the water quality samples until they are transferred to a licensed courier. The sampler's responsibility will include:

- Labeling and sealing all sample containers (including custody seals, when appropriate)

- Properly packing the samples with ice for shipment to the laboratory

- Notifying the courier about a sample pick-up and preparing any airbills for shipping samples to the laboratory

- Initiating chain of custody forms

- Notifying the laboratory of all sample shipments

- Assuring that samples are shipped to meet the applicable holding time(s)

A chain-of-custody form will accompany each sample cooler and include the following information.

- Project name or number
- Sampler's name and signature
- Sample identification number(s)
- Date and time of sample collection
- Sample matrix
- Number of sample containers
- Analyses requested
- Filtration completed or required
- Method of shipment (with airbill number if applicable)
- Any additional instructions for the laboratory

Upon receipt, laboratory personnel will inspect the samples and record their condition and temperature on the chain-of-custody form. The laboratory will immediately report the presence of broken custody seals to MWH's project laboratory liaison. The laboratory liaison, after consulting with the Project Manager and the laboratory's project manager, will decide whether or not to analyze the samples. Decision criteria that will be used to help in determining if the samples should be analyzed include:

- If the cooler custody seal is broken is there any sort of documentation that may indicate who broke the seal, e.g., a customs declaration, or a notation from the shipping company;

    - The samples can be analyzed

- If the cooler appears intact, and the samples inside are ok, e.g., the individual bottle custody seals are intact;

    - The samples can be analyzed

- If the cooler custody seal, and the individual bottle seal(s) have been compromised;

    - Then the samples should not be analyzed

The COC forms will be completed by the laboratory and forwarded with the final laboratory results.

5.0 REFERENCES

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STANDARD OPERATING PROCEDURE

SOP-2
GROUNDWATER SAMPLE COLLECTION

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes methods and equipment commonly used for collecting environmental samples of groundwater for either on-site examination and chemical testing, or for laboratory analysis. It also describes procedures for sample handling, labeling and documentation. The information presented in this SOP is generally applicable to all environmental sampling of groundwaters except where the analyte(s) may interact with the sampling equipment.

This document describes multiple methods and a variety of equipment. Appropriate methods and equipment will be selected based on the sampling and analysis plan and site conditions. Specific sampling problems may require the adaptation of existing equipment or design of new equipment.

This technical procedure establishes a uniform methodology to ensure that high quality samples, representative of the groundwater resource of interest, are consistently obtained. The scope is intended to provide guidance while preparing for, and conducting, field sampling activities. The SOP should be used with a project specific field monitoring plan and quality assurance project plan.

The groundwater collection procedures presented in the following sections were developed using standard industry-accepted practices, as well as international organization and agency guidelines and standard practices. The same care must be exercised in implementing field investigations and sampling events that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada (U.S.) Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)

2.0 DEFINITIONS

2.1 DEDICATED PUMP SYSTEM

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become contaminated between uses.

2.2 NON-DEDICATED SAMPLING APPARATUS

A non-dedicated sampling apparatus is sampling equipment that may contact groundwater samples from more than one well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

Examples of non-dedicated equipment include a pump used to sample multiple wells, bailers and field meters.

2.3 BAILER

A bailer is a tubular device, with a check-valve at the top and/or bottom used for collecting and removing groundwater from wells. The three most common types of bailers are as follows:

- Single check value: A single check valve sampler collects the sample from the top of the water column. The typical sample transfer occurs by inserting a tube into the bottom of the bailer, pushing up the check valve which allows the water to be released into the sample container. If used for VOC sampling the bailer should have a sample cock or draft valve at or near the bottom of the sampler allowing withdrawal of the sample from the well below the exposed surface water. Otherwise, discard the first few centimeters of sample at the bottom of the sampler.

- Double check value: The double check valve sampler allows for point source sampling at a specific depth. The liquid will pass through the sampler while it is descending until the desired depth is reached. Once retrieval of the sample commences, both check valves close simultaneously, thereby allowing the specific depth to be sampled.

- Thief or messenger sampler: This type of sampler also allows for point source sampling at a specific depth. A weighted messenger is dropped down the suspension line and closes the sampling vessel thus obtaining a sample at the desired depth.

To avoid potential sources for contamination keep the bailer suspension lines off the ground and away from any other potentially contaminating sources to minimize the possibility of being carried down into the well. If needed, a decontaminated tarp or plastic bag is recommended for storage of the bailer suspension line.

2.4 POSITIVE PRESSURE PUMP

A positive pressure pump is a device for removing water from well by forcing water to the surface through positive pressure when operated below the water level in a well. A positive pressure pump may be operated electrically, mechanically, or by air/nitrogen pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

2.5 SUCTION LIFT PUMP

A suction lift pump is a device for removing water from well by negative pressure (suction). Direct line, peristaltic and centrifugal pumps are the three types of suction lift pumps. The limitation for lifting water by suction is usually six to eight meters. These pumps are only acceptable for non-volatile analytes and analytes that are not affected by aeration or changes in pH. They are useful as purging devices for shallow groundwater wells.

MWH prefers to use the peristaltic pump when a suction lift pump is required. This is the only suction lift pump, of the three mentioned above in which the liquid being sampled moves entirely within the sample tubing. The groundwater sample never contacts the actual pump apparatus during sampling thus eliminating a possible source of sample contamination from the actual pump, lubricants or parts.

Standard silicon tubing is the most commonly used sample tubing. Most pump manufacturers and rental companies offer acceptable tubing lined with TFE-fluorocarbons or Viton. Medical grade silicon tubing is recommended for organic sampling by the National Council of the Paper Industry for Air and Stream Improvement; however, it is limited to use over a restricted range of ambient temperatures. Standard silicon tubing uses an organic vulcanizing agent, which has been shown to leach into samples.

2.6 WELL STORAGE VOLUME

Well storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack at equilibrium.

2.7 GROUNDWATER SAMPLE

A groundwater sample is defined as water acquired from a well for chemical analyses that is representative of groundwater within the aquifer or the portion of the aquifer being sampled.

2.8 SAMPLE BOTTLES

Sample bottles are containers specifically designed and prepared for storing liquid samples. Sample bottle type, material, size, and type of lid are specific for particular groups of analytes. Sample bottles must be properly cleaned and prepared by a laboratory or the bottle manufacturer. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

2.9 ACCEPTABLE MATERIAL

Acceptable materials are defined as pump systems that have minimal effect on water quality when used to obtain groundwater samples from wells. The use of permissible pumps is dependent on the analyses being conducted on the acquired samples. The parts of permissible pumps that will contact the groundwater sample contain only acceptable materials.

3.0 REQUIRED GENERAL PROCEDURES

The following is a listing of general procedures that should be followed during every sampling event.

- Groundwater samples will be collected in quantities and types as directed by the Project Manager and project work documents.

- Water level data collection (see SOP-4 Groundwater Level Measurement).

- Determination of well storage volume (see Section 6.2.2).

- Prior to collection of groundwater samples, the well (or piezometer) should be purged.

- All instruments used for field analyses should be calibrated in accordance with the instructions provided.

- All non-dedicated sampling equipment will be decontaminated before and/or after each use.

- Samples will be collected in properly prepared containers of the appropriate size and type. All samples will be appropriately labeled and sealed.

- Samples will be stored and transported in coolers at 4-degrees Celsius. Chain-of-custody will be maintained in accordance with chain-of-custody procedures

- Daily field activities and sampling events will be documented in the field logbook and field data sheets.

- All variations from established procedure will be documented on the field data sheets, the field logbook and will be approved by the Project Leader.

4.0 EQUIPMENT AND MATERIALS

If wells are equipped with permissible and dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.) as well as and non-dedicated sampling apparatus, such as surface discharge tubing and valving or bailer(s) for sampling free floating product, may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample will be made of acceptable materials.

Sample bottles and preservatives appropriate for the parameters to be samples will be necessary. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

Field test equipment:

- pH meter and standards
- Conductivity meter and standards
- Dissolved oxygen meter
- Turbidity meter and standards
- Thermometer
- Filtration apparatus (0.45 micron)
- Water-level measuring device
- Coolers and ice packs
- Distilled or deionized water
- Decontamination equipment (scrub brushes, gloves etc.) and solutions (non-phosphate detergent)
- Permanent, waterproof ink pens and markers
- Sample labels and seals
- Well specifications
- Field data sheets and logbook
- Chain-of-custody forms (provided by selected laboratory)
- Plastic sheeting (disposable)

5.0 SAMPLE COLLECTION PROCEDURE

5.1 DECONTAMINATION

All non-dedicated sampling equipment that may contact the sample must be decontaminated at the beginning of each sampling day and after each use. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment will first be washed with clean tap water (whose chemistry is known and acceptable), then washed with a non-phosphate detergent, followed by a triple rinse of distilled water.

5.2 SAMPLE QUANTITIES, TYPES, AND DOCUMENTATION

Samples will be collected in quantities and types as specified in the filed sampling plan and project objectives.

Daily field activities and sampling events will be documented in the field logbook and field data sheets. Samples will be transferred to the analytical laboratory(s) under formal chain-of-custody procedures.

5.3 SAMPLE CONTAINERS

All sample bottles must be properly cleaned and prepared. Coordinate with selected analytical laboratory for appropriate sample bottle types and preparation requirements. All groundwater samples will be labeled and sealed and immediately placed in 4 degrees Celsius coolers with securely closed lids and custody seals on the outside of the cooler for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time. A temperature blank will be placed inside each cooler to verify the internal temperature of the cooler upon arrival at the laboratory.

5.4 ACCEPTABLE MATERIALS

Stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA) are acceptable materials that may contact groundwater samples. Glass is an acceptable material for contacting samples except when silica or fluoride analysis are to be performed. Plastics (PVC, polyethylene**,** polypropylene, tygon) are an acceptable material for contacting samples when the analyses are for inorganic analytes (general water quality indicators, major anions and cations, trace metals and radionuclides).

5.5 GROUNDWATER SAMPLE COLLECTION

This section provides guidance for collecting a representative groundwater sample, which can be used for water quality characterization. There are three steps included in the sample collection process:

1) Groundwater-level measurement
2) Well purging
3) Sample collection

5.5.1 Groundwater-level Measurement

Groundwater-levels will be measured before well purging to allow calculation of a casing volume. The water level will be measured after purging to verify that it has recovered to at least 80% of the static water level prior to sampling.

Water-level measurements will be made directly using an electronic water-level sounder. The sounder consists of a graduated tape, accurate to 0.01-feet, with a probe at the end of the tape. The probe is lowered into the well until water or moisture is encountered activating audible and visual signals on the instrument reel at the surface. The water level is then read directly from the graduated tape.

5.5.2 Well Purging

Water that remains in a well between sampling events may not be representative of groundwater in the water-bearing unit. Purging is required to remove this stagnant water and allow formation water to enter the well screen and casing. Purge water from a well using the same type of device (pump or disposable bailer) that will be used for sampling.

Groundwater samples will be removed from the well with the use of a permissible pump or bailer. Electric-powered positive-pressure pumps, as defined in Section 2.5, made of acceptable materials are permissible to use for acquiring any groundwater sample. Air/nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the air/nitrogen does not contact the sample. Positive-pressure pumps that mechanically force water through check valves are also permissible for acquiring groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples.

Peristaltic pumps and airlift pumps are not the preferred equipment for acquiring groundwater samples but are permissible when samples are to be analyzed for analytes that are not volatile, are not affected by aeration, and are not affected by changes in pH. Other types of pumps (air-lift, centrifugal, peristaltic, recirculation, etc.) may be used for purging groundwater from wells prior to sample acquisition, if:

(1) pump materials contacting groundwater are acceptable;

(2) pumping does not aerate or change the pH of the groundwater; and,

(3) pumped water does not mix with remaining formation water during pumping or after the pumping is stopped.

Prior to any evacuation or sampling, all pumps and other sampling devices that are not disposable will be decontaminated.

A minimum of three well casing volumes will be recovered during the purging operation, if possible. However, it may be impractical to purge three casing volumes. If this is the case, then:

- If the well contains a small volume of water purge the well dry, and after allowing for a minimum recovery of twelve hours, collect the sample.

- If the well contains to great of a volume to be evacuated using a small disposable bailer, check field water quality parameters a minimum of five times. If the parameters appear to stabilize; e.g., no more than a ten-percent difference among the last three values; collect a sample. If this process does not work, then another type of evacuation device is needed.

Depth to water (DTW) and total well depth (TD) will be measured prior to purging the well to calculate the volume of water that needs to be evacuated. A casing volume (CV) is calculated using the following equations:

$$WC = (TD - CS) - (DTW-CS)$$

and,

$$\text{gallons/foot} = (D)^2/24.5$$

and,

$$CV = \text{gallons/foot} \times WC$$

where,

WC = height of the water column in feet
TD = total well depth in feet (from top of casing)
CS = casing stick-up in feet
DTW = depth to water level surface (from top of casing) (feet)
gallons/foot = number of gallons of water per one foot of casing
D = inside diameter of the casing in inches
CV = one casing volume in gallons

Field water quality parameters will be measured and recorded for each well volume purged:

- pH
- specific conductivity
- dissolved oxygen
- temperature

If these parameters have not stabilized (± ten percent) after purging three well volumes, additional purging may be performed. The meters and probes will be rinsed with distilled or de-ionized water between each casing volume.

If a monitoring well or piezometer is artesian, or exhibits artesian characteristics during any particular sampling event, then well purging is not required for that event.

All purging activities will be thoroughly documented on the groundwater data sheet and in the field logbook to assure that the adequacy of the procedures can be evaluated.

5.5.3 Collecting the Groundwater Sample

5.5.3.1 Groundwater Sample Collection for Laboratory Analyses

Groundwater aliquots will be composited in a splitter container, and the raw water samples will be transferred directly from the splitter container to the laboratory sample container. For those samples that require filtration, the groundwater sample will be transferred through the filtration apparatus to the laboratory sample container.

Major Cations, Trace Metals and Total Dissolved Solids

Samples for major cations, trace metals and total dissolved solids (TDS) will be immediately filtered after acquisition. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the pump discharge port, bailer, or splitter container, through the filter and into the appropriate sample bottle. The filter pore size will be 0.45 micron. New filters and filter tubing will be used for each sample. The groundwater samples for metals analyses will be preserved with nitric acid ($HN0_3$) to a pH less than 2. The TDS samples will not be acidified. The sample bottles will be 0.5-liter or 1-liter high-density polyethylene (HDPE) containers.

The project objectives or field sampling plan also may specify the collection of raw, or unfiltered metal sample aliquots. These aliquots will be collected directly from a pump discharge port, bailer, or splitter container into appropriate sample bottles and preserved with nitric acid ($HN0_3$) to a pH less than 2. The only exception is analysis of chromium VI, in which case preservatives will not be added to the sample.

Cyanide

Samples for cyanide analyses will be collected directly into appropriate sample bottles from the splitter container, bailer or the pump port. Samples will not be filtered nor should they be allowed to overflow the sample bottle. Samples will be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12. The appropriate bottle will be 0.5-liter or 1-liter HDPE container.

Major Anion, Biological Oxygen Demand, pH and Total Suspended Solids

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity), biological oxygen demand (BOD), pH, and total suspended solids (TSS) will be collected directly into appropriate sample bottles from the bailer, pump discharge port or splitter container. These samples will be un-filtered and un-preserved. The sample bottles for major anions, pH and TSS will be 0.5-liter or 1-liter HDPE containers. BOD samples will be transferred to 0.25-liter or 0.5-liter glass bottles.

The sample bottle for BOD will be filled to the very top to eliminate any headspace. There should be no air bubbles in the bottle once the cap has been fastened; if air is present, a new sample will be taken by the same procedure.

Nitrogen Species, Total Phosphate, Chemical Oxygen Demand, and Oil and Grease

Groundwater samples for nitrogen species (nitrate [NO_3], nitrite [NO_2], total kjeldahl), total phosphate, chemical oxygen demand (COD), and oil and grease analyses will be raw, unfiltered aliquots. The sample bottles will be filled directly from the splitter container, bailer or pump discharge port. The appropriate bottle for nitrogen species and total phosphate sample analyses is a 0.5-liter or 1-liter HDPE container. Oil and grease samples will be collected in 1-liter amber glass bottles. The COD samples will be collected in 0.5-liter glass bottles. Samples will be preserved with sulfuric acid (H_2SO_4) to pH less than 2.

Oil and grease samples will be collected in 1-liter amber glass bottles. The COD samples will be collected in 0.5-liter glass bottles. Samples will be preserved with sodium thiosulfate ($Na_2S_2O_3$).

Extractable Base-Neutral/Acid Organics, Phenolic Compounds, PCB and Pesticides

Samples for extractable base-neutral/acid organic, phenolic compound, PCB and/or pesticide analyses will be collected directly from a pump discharge port, bailer or splitter container in appropriate sample bottles with teflon lined lid and appropriate preservative. Samples should not be allowed to overflow the sample bottle and will not be filtered.

Purgeable Volatile Organics

Samples for purgeable volatile organics will be obtained after other bottles (for other analytes) have been acquired for each well. Samples for purgeable volatile organics will be extracted from the well using a pump or bailer and will be collected directly from the pump discharge tube, bailer or splitter container into properly cleaned and prepared 40 ml or 125 ml glass vial. The vial will be allowed to overflow approximately 2 to 3 vial volumes. Contact with air and sample agitation should be minimized. If necessary, pumping rates will be significantly reduced during sampling for volatile organics. These samples will not be filtered or preserved. Immediately after collection, a teflon lined silicon septum cap will be tightened onto the vial. There should be no air bubbles remaining within the vial once the cap has been fastened; if air is present, a new sample will be taken by the same procedure. Samples for purgeable aromatic hydrocarbons (EPA Methods 602 or 8020) may be preserved with hydrochloric acid (HCl) to increase holding time.

5.5.3.2 Field Parameter Measurements

Unfiltered aliquots of the groundwater also will be collected for field water quality parameter (pH, specific conductivity, turbidity, temperature, and dissolved oxygen) measurement, recording the in-field measurements on the field data sheet and in the field book.

Calibration of Instruments

All instruments used for field analyses will be calibrated daily prior to use, at a minimum. Calibration will be in accordance with the manufacturer's specifications (provided with the instrument).

pH

A pH meter will be used to measure the pH of the sample on sample of purged water that was obtained just before or after sampling. Measurements will be made immediately on the obtained sample. Calibration will be in accordance with the manufacturer's procedures (provided with the instrument). Calibration will be performed with standardized buffered pH solutions bracketing the range of expected pH and conducted at the beginning of each day. After each reading, the probe will be thoroughly rinsed with distilled or deionized water. The pH will be recorded to one-tenth (or one-hundredth if meter is stable enough) of a pH unit.

Conductivity Measurement

A conductivity probe will be used for conductivity measurement on an aliquot of purged water obtained just before or after sampling. Measurements will be made as soon as possible on the obtained aliquot. The meter will be calibrated in accordance with manufacturer's procedures (provided with the instrument) with standardized KCl solutions. At a minimum, calibration will be performed at the beginning of each day's use. The conductivity will be recorded to two significant figures. The temperature of the sample at the time of conductivity measurement will also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use.

Water Temperature

A thermostat contained in the pH or conductivity meter will be used to measure the temperature of the water on an aliquot of purged water obtained just before or after sampling. The thermometer reading will be allowed to stabilize and will be recorded to the nearest 0.1 degree centigrade.

Dissolved Oxygen Measurement

A dissolved oxygen meter is used to measure dissolved oxygen (DO) in groundwater samples. Measurements will be made immediately on aliquots obtained just before or after sample acquisition. The probe must be thoroughly rinsed with distilled or deionized before and after each use. Measurements will be recorded to the nearest 0.1 mg/l (parts per million [ppm]) concentration.

Turbidity Measurements

A portable turbidity meter will be used to make turbidity measurements on aliquots of water samples obtained just before or after sample acquisition. Measurements will be made as soon as possible on the obtained aliquot. The outside of the glass vials used for containing the aliquot for measurement must be wiped thoroughly dry before and after each use. Measurements will be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

5.6 CAPTURE AND DISPOSAL OF PURGE WATER AND DECONTAMINATION SOLUTIONS

5.6.1 Purge Water

If stipulated by the project objectives and field monitoring plan, purged groundwater will be captured and contained in 55-gallon drums or suitable tank(s). If required, each drum or tank containing captured purge water will be properly labeled with a label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks will be as specified in the project work documents or as directed by the Project Manager.

Captured and contained purge water will be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the project work documents or by the Project Manager, but could rely on the analytical results of groundwater samples associated with each drum or tank, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as chemical consistency, local regulations, and location of site. Discharge, treatment and, or disposal of captured and contained purge water must be in accordance with local, state and federal regulations and will be specified in the project work documents.

5.6.2 Decontamination Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent weak acid rinses, any spent methanol rinses; and spent final distilled or de-ionized water rinses. Spent acid and methanol rinses will be captured and contained in plastic buckets or drums. Other spent decontamination waste solutions will be captured and contained in appropriately sized buckets or drums if a reasonable potential exists for the spent solutions to contain hazardous substances. Project work documents will address, or the Project Manager will determine, whether spent decontamination solution requires capture and containment.

Captured and contained decontamination solutions will be subject to the same procedures as described for purge water. Some differences are as follows:

(1) acid solutions will be neutralized with lime prior to discharge or disposal;

(2) methanol solutions may be able to be evaporated if segregated from other decontamination solutions, if generated in small enough quantities, and if conditions are favorable; and,

(3) if quantities are sufficiently small, decontamination solutions (detergent washes, rinse waters, neutralized acid solutions) may be added to the captured and contained purge water that corresponds to the same well sampling effort.

6.0 SAMPLE HANDLING AND DOCUMENTATION

Documentation for sampling groundwater includes labeling sample bottles, completing field data sheets and chain-of-custody records and securing individual samples or sample coolers with chain-of-custody seals.

6.1 SAMPLE HANDLING

6.1.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, sample bottles will be obtained directly from the analytical laboratory, or laboratory supply-house. The bottles will be labeled (see following section) to indicate the type of sample and sample matrix to be collected. Sample bottles can be either pre-preserved from the laboratory or preservatives can be added in the field during sample collection. In general, 0.5-liter or 1-liter polyethylene or glass bottles will be used for the sample bottles that will be submitted for analysis of general chemical constituents, major inorganic constituents and metals.

Laboratory sample containers will be filled one by one at the monitoring location, secured with the container lid, and any excess water wiped off the exterior. Immediately after collection, the containers will be placed in field coolers with ice. Glass containers will be wrapped with bubble wrap or other appropriate shipping material to prevent breakage.

6.1.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to assure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping.

For all samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

6.1.3 Sample Holding Times

Sample holding times are established to minimize chemical changes in a sample prior to analysis and, or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and, or extraction, based on the nature of the analyte of interest and chemical stability factors.

To meet recommended holding times, <u>most</u> **samples will be shipped to the analytical laboratory in iced coolers as soon as possible or within 48 hours of collection**, if conditions permit**.**

6.1.4 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described above, and placed on ice in an insulated cooler. The sample containers should be placed in re-sealable plastic storage bags. Samples should be stored in an upright position. Coolers sent to the analytical laboratories should be chilled with ice. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to assure that the cooler cannot be opened without breaking the seal.

6.2 FIELD DOCUMENTATION

Documentation establishes procedures, identifies written records, enhances and facilitates sample tracking, standardizes data entries, and identifies and establishes authenticity of the sample data collected. Proper documentation also:

- Assures that all essential and required information is consistently acquired and preserved
- Documents timely, correct, and complete analysis
- Satisfies quality assurance requirements
- Establishes chain-of-custody
- Provides evidence for court proceedings
- Provides a basis for further sampling

6.2.1 Field Documentation

Appropriate field records will be completed in a bound field logbook and, or field data sheets at each site at the time of sample collection. All aspects of sample collection and handling as well as visual observations will be documented in the field logbooks. In general, field logbooks as well as field data records should:

- Record, identify and describe all pertinent sampling and monitoring activities.
- Record quantitative and qualitative information for each sample collected.
- Record and describe all field team activities, including observations and events.

At a minimum, the following information will be recorded in the field at each monitoring station:

- Site location
- Sampler name(s)
- Date and time of sample collection
- Sample identification number(s)
- Type of sample (stream, spring, groundwater, potable water)
- Field water quality measurements (pH, conductivity, temperature, turbidity, DO)
- Sample handling (including filtration and preservation, as appropriate)
- How sample collected (e.g. grab, composite, bailer)
- Number and type of any QA/QC samples collected
- Spring discharge or stream flow, including measurement method (if applicable)
- Depth to groundwater (if applicable)
- Well purge volumes and time (if applicable)
- Casing stick-up (if applicable)
- Weather conditions, including recent precipitation and approximate air temperature
- Field observations, including any unusual conditions or activities in the area

Changes or deletions in the field logbook or on field data forms (see Attachment) should be lined out with a single strike mark and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory. All field notebooks and data forms will be signed at the end of each day.

6.2.2 Chain-of-Custody

A chain-of-custody (COC) record is used to record the custody and transfer of all samples. The field sampler will be responsible for the care and custody of the water quality samples until they are transferred to a courier, and ultimately, the analytical laboratory. The sampler's responsibility will include:

- Labeling and sealing all sample containers (including custody seals, when appropriate)
- Properly packing the samples with ice for shipment to the analytical laboratory
- Notifying the courier about a sample pick-up and preparing any airbills for shipping samples to the laboratory
- Initiating chain-of-custody forms
- Notifying the laboratory of all sample shipments
- Assuring that samples are shipped to meet the applicable holding time(s)

A chain-of-custody form will accompany each sample cooler and include the following information:

- Project name and address
- Project number
- Sampler's name and signature
- Sample identification number(s)
- Date and time of sample collection
- Sample matrix
- Number of sample containers
- Analyses requested
- Filtration completed or required
- Method of shipment (with airbill number if applicable)
- Any additional instruction for the laboratory

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ATTACHMENT

GROUNDWATER PURGING AND SAMPLING FORM

MWH
MONTGOMERY WATSON HARZA

Well Identification	
Well Diameter (in)	
Well Head Monument Locked and in Good Condition?	
Inside Well Head and Outside Well Casing (D= dry) (WAC= Water Above Well), (WBC= Water Below Casing)	
Well Casing Plug Locked and in Good Condition?	
Time Measured/ Depth to Groundwater (ft)	
Well Total Depth (ft)	

Site Location: ______________ Date: ____________________

Project No: __________________ On-Site Personnel: ________________________________

Purge Method: _____ Low Flow _____ Conventional

Purging Equipment: _____ Disposable Bailer; _____ Peristaltic Pump; _____ Bladder Pump; _____ Other

Sampling Equipment: _____ Disposable Bailer; _____ Peristaltic Pump; _____ Bladder Pump; _____ Standpipe; _____ Spigot

Weather: _____ Temperature (°F); _____ Rainy; _____ Snowy; _____ Windy; _____ Cloudy; _____ Sunny

Well Volume Calculation:
Water Column (ft) x Multiplier (2" = 0.16, 4" = 0.64, 6" = 1.44) = Casing Volume (gallons)

Time (Purging Started:)										
Purge Rate (mL/min), (L/min) or (other)										
Groundwater Purged (mL), (L) or (other)										
pH										
Conductivity (mS/cm) [control limit: +/-0.01 mS/cm]										
Turbidity (NTU)										
Dissolved Oxygen (mg/L) [control limit: +/- 0.2 mg/L]										
Temperature (°C)										
ORP (mV)										
Well Dewatered? (Yes or No)										
Color of Purged Water: (G= grayish), (B= brownish), (R= reddish), (C=clear), (SP= suspended particulate)										
Odor: (P= Petroleum), (S= rotten egg), (N= none), (O= other?)										

Time Sampled: ____________ **Sample Identification:** ______________________________

Analysis: ____

Sampler Signature(s): ____

Comments:

Hydrogen Sulfide: **Ferrous Iron:**

Purge Water Disposal To: ______________________
____ Ground Surface ____Other

STANDARD OPERATING PROCEDURE

SOP-3
SURFACE WATER FLOW MEASUREMENT

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1.0 PURPOSE AND SCOPE

This technical procedure describes general methodologies for collecting surface water flow measurements from streams, rivers, springs, irrigation canals and open culverts. For any variation from this standard operating procedure (SOP), the work plan will take precedence.

This SOP is designed to cover general techniques for obtaining valid, representative flow measurements from surface waters in open conduits. The scope is intended to provide guidance while preparing for, and during, actual field sampling activities for a particular project.

This SOP describes methods for measuring surface water discharge in streams, seeps, adits, and pipes. Discharge is defined as the volume rate of flow of water, expressed in cubic feet per second (cfs), including any substances suspended or dissolved in the water. Methods for measuring discharge are based on a variety of flow conditions. Many discharge measurement methods are required because flow conditions differ from site to site. This SOP describes probable flow conditions that may be encountered and methods used to obtain discharge measurements. A complete discussion of all available flow measurement techniques and the theory behind them is beyond the scope of this text.

Because of the dynamic nature of surface water behavior, flow measurement by the methods described in this document may, on occasion, be impossible at some sites. It is understood that if unmeasurable flow conditions are encountered at any of the surface water data collection sites which are to be measured in this program, the field team will attempt to measure flow at a point upstream or downstream of the site and will note this point relative to the marked data collection point. Whether or not a measurement is made, the team will note the conditions that inhibited accurate flow measurement.

Selection of the streamflow measurement methods in this SOP were based on the following conditions:

- Permanent control structures (such as flumes or weirs) may exist at some of the sites

- In the absence of a permanent control structure such as a flume, a current meter, or a portable flume or weir may be used to measure discharge

- Staff gages may be installed at sampling station locations identified in the surface water monitoring program; and

- A few locations may be appropriate for volumetric measurement of discharge

The method of discharge measurement to be used at each site will be described in the field notebook for the site. Each of these methods will be presented in the following format:

- Method name
- Required measurement conditions
- Equipment
- Maintenance and calibration procedures
- Field procedures
- Discharge calculations

2.0 PROCEDURES

2.1 CONTROL STRUCTURES

Permanent control structures such as weirs and flumes can be used to determine discharge. These structures have regular dimensions that allow for a constant relationship between water level and discharge. This section describes the use of Parshall and cutthroat flumes to measure discharge. This section also provides general guidelines for the use of weirs in measuring discharges.

2.1.1 Theoretical Considerations

A calibrated constriction placed in a stream channel changes the level of the water in or near the constriction. By knowing the dimensions of the constriction, the discharge though the constriction will be a function of the water level. A simple depth determination near the constriction provides a discharge measurement. Flumes are constructed so that a restriction in the channel causes the water to accelerate, producing a corresponding change (drop) in the water level. The head can then be related to discharge.

Flumes are specially shaped, open-channel, flow sections with a restriction in channel area and, in many examples, with a change in channel slope. Either or both of these shape changes cause velocities to increase and water levels to change while passing through the flume. Typical flumes consist of three sections:

- A converging section to accelerate the approaching flow
- A throat section, whose width is used to designate flume size
- A diverging section, designed to ensure that the level downstream is lower than the level in the converging section

The stage of a stream is the height of the water surface above an established datum plane. The water-surface elevation referred to some arbitrary gage datum is called the "gage height." Stage or gage height is usually expressed in feet or inches.

2.1.2 Required Measurement Conditions

Ideally, flowrate through a flume may be determined by measurements at a single point some distance downstream from the inlet and above the throat. The single measurement indicates the discharge rate only if critical or supercritical flow is achieved in the flume. By definition, critical flow is that for which the ratio of inertiaforce to the force due to gravity (Froude number) is unity. Supercritical flow occurs when the Froude number, F, exceeds unity; this flow has a high velocity and is usually describedd as rapid, shooting and torrential. If the Froude number is less than one, subcritical flow occurs, commonly due to a condition referred to as submergence; this flow has a low velocity and is often described as tranquil and streaming. Additional information concerning the use of flumes under all flow conditions, including submergence, is presented in Rantz and others (1982).

2.1.3 Equipment

For purposes of discharge measurements, existing flumes located at surface water data collection sites will be inspected and measured prior to use in the surface water program. Additional flumes may be installed at some sites as warranted.

Parshall Flume: The Parshall flume consists of a converging section with a level floor, a throat section with a downward sloping floor, and a diverging section with an upward sloping floor. The principal feature of the Parshall flume (developed by R. Parshall in 1922) is an approach reach having converging sidewalls and a level floor, the downstream end of which is a critical-depth cross-section. Critical flow is established in the vicinity of that cross-section by having a sharp downward break in the bed slope of the flume. The bed slope downstream from the level approach section is therefore supercritical. The primary stage measurement is made in the approach reach at some standard distance upstream from the critical-depth cross-section. The Parshall flumes are equipped with standard USGS vertical staff gages. The staff gages will be used to measure gage height to the nearest 0.02 of a foot. The stage/discharge relationship is provided by the manufacturer.

Cutthroat Flume: The cutthroat flume lacks a parallel-wall throat section. It is a flat-bottomed device whose main advantage is extreme simplicity of form and construction. The level flume floor permits placing the device directly on an existing channel bed, without further excavation. The rectangular cutthroat flume is dimensionally defined by a characteristic length, L, and by the throat width, W. All other flume dimensions are derived from these two dimensions. For free flow conditions, on the head H_a at the upstream gage location is needed to determine discharge. For submerged conditions, both the upstream head and the downstream head (H_b) are required.

Type VI Flume: A type VI flume is a flume that uses the channel bed gradient to achieve supercritical flow conditions. There is no contraction in the flume width as occurs with the Parshall and cutthroat flumes. A slope of one degree is usually sufficient to produce critical depth in the vicinity of the upstream edge of the flume. However, a slope ranging from two to five percent is better because it prevents the creation of waves and disturbances that could hinder free flow downstream.

Depth Measuring Device: Flumes are equipped with standard USGS vertical staff gages. The staff gages will be used to measure gage height to the nearest 0.02 of a foot.

2.1.4 Maintenance and Calibration Procedures

All flumes will be inspected prior to measurement of discharge to determine that the flume is discharging freely. Any problems observed during the inspection will be noted and reported in the field book.

2.1.5 Field Procedures

If the site is equipped with a Parshall or cutthroat flume, then discharge will be measured according to the following procedures:

- Remove any material that may have accumulated in the flume
- Note any deterioration of the flume
- Measure and record the throat width to the nearest 0.01 of a meter
- Record the time and date of the site visit
- Use the staff gage to measure and record the gage height to the nearest 0.01 of a meter
- Calculate discharge from the stage/discharge table
- Record the calculated discharge

For the type VI flume, a stage/discharge curve must be developed. The following steps will be used to develop the curve.

- Remove any material that may have accumulated in the flume
- Record the staff gage height to the nearest 0.01 meter
- Determine the discharge through the flume using the velocity-area method (see following section)
- Plot the staff gage height against the measured discharge and fit the points with a regression line
- The stage/discharge curve will be most accurate if several points are plotted for low flow, moderate flow and peak flow conditions.

After the curve has been developed, future flow measurements are calculated by reading the staff gage height and using the stage/discharge curve to estimate the corresponding discharge. The curve should be verified periodically by using the velocity-area method to measure the discharge and checking it against the established curve.

2.2 VELOCITY-AREA METHOD

Surface flow in open conduits such as stream channels that are greater than 1-foot wide, or where flow exceeds 2.0 cfs, will be measured by using the velocity-area method.

<u>Vertical Axis Current Meter</u>

The vertical axis current meter is one type of meter that is commonly used. It is desirable for the following reasons:

- This meter operates in lower velocities than the horizontal-axis meter
- Bearings are well-protected from silty water
- Rotor can be repaired in the field without adversely affecting the measurement
- Single rotor serves for the entire range of velocities

A common type of vertical axis current meter is the Price current meter, Type AA. The standard Price meter has a rotor 5-inches in diameter and 2-inches high with six cone-shaped cups mounted on a stainless steel shaft. A pivot bearing supports the rotor shaft. The contact chamber houses both the upper pan of the shaft and a slender bronze wire ("cat's whisker") attached to a binding post. With each revolution, an eccentric contact on the shaft makes contact with a bead of solder at the end of the cat's whisker. A separate reduction gear (pentagear), wire, and binding post provide a contact each time the rotor makes five revolutions. A tailpiece keeps the meter pointing into the current.

In addition to the type AA meters, the USGS and others use a Price pygmy meter, a Swoffer meter, or similar device in shallow depths. The pygmy meter is scaled two-fifths as large as the standard meter and has neither a tailpiece nor a pentagear. The contact chamber is an integral part of the yoke of the meter. The pygmy meter makes one contact per revolution. The Swoffer is also a scaled meter, and also lacks a tailpiece or pentagear. The meter makes one contact per revolution, which is recorded on the digital display.

Marsh-McBirney Velocity Meter

Portable Marsh-McBirney flow meters are a type of current meter that may be used in the velocity area flow measurement. Either Model 201D or Model 2000 will be acceptable for the required gauging. The Marsh-McBirney meters measure flow velocity using the Faraday principle, which states that as a conductor moves through and cuts the lines of a magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field.

The Marsh-McBirney flow meter will be calibrated annually using a factory approved flow loop or tow tank. This procedure involves moving water past the meter at a known velocity or moving the meter at a known velocity through water. The velocity indicated by the meter is adjusted until the proper reading is obtained.

The sensor on the Marsh-McBirney meter can be connected to the universal sensor mount on the top-setting wading rod and used to determine flows using either the six-tenths depth method of the two-tenths and eight-tenths depths method. The minimum flow depth at which an average velocity can be measured with the Marsh-McBirney meter set at six-tenths of total depth is approximately 0.05 meters. Velocities can be estimated in flows as shallow as 0.03 meters. The meter is capable of measuring velocities ranging from 0.0 to 6 meters per second.

2.2.1 Theoretical Considerations

The volume rate of flow of water, which is commonly called discharge (Q), is the product of multiplying the average velocity (V) times the total cross-sectional area (A):

$$Q = VA$$

The current meter measures velocity at a point. The velocity-area method of making discharge measurements at a cross-section requires measurement of the mean velocity in multiple portions of the cross-section at each of the selected verticals. These are taken at subsections of the cross-section. A complete discussion of area-velocity methods is found in Rantz and others (1982).

By dividing the stream width into subsections, total discharge becomes the total of discharges measured in each subsection (see Figure 1). Individual point velocity (v) is measured at each subsection, and discharge becomes the sum of the products of each point velocity and cross-sectional area (a) of each subsection:

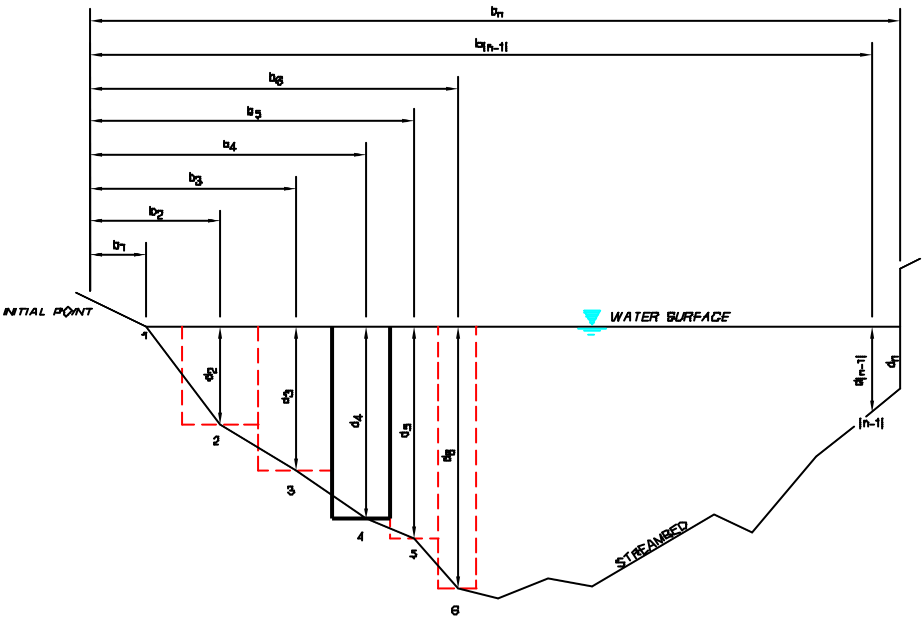
$$Q = Sva$$

where:
Q = total discharge,
v = point velocity, and,
a = area of the subsection.

Note that, in Figure 1, the cross-section is defined by depths at verticals 1, 2, 3, 4,... n. At each vertical, the average velocity is measured by a current meter.

The current-meter measurements performed in channelized streams will be based on selecting subsections to contain approximately 10 percent or slightly more of the total discharge. However, the stream should not be partitioned into sections that are significantly greater than 10 percent of the total stream flow because individual measurements that may be in error will then have a significant impact on the overall average velocity determination.

In general, depending on average depth and velocity distribution, a stream less than 2-feet wide will require no more than 8 to 10 subsections. A stream up to 4-feet wide will require about 10 to 12 subsections. Streams wider than 4-feet will require more subsections. Table 1 shows a breakdown of the number of recommended subsections. Further, subsections need not be of identical width. For example, because velocities near banks are generally lower than velocities near the center of streams, these subsections may be wider than subsections near the center. Subsections will also be more closely spaced if a stream has an unusually deep portion in the cross-section, or if velocities are higher than usual for the cross-section. Velocity will be observed at each point for a period that ranges from 40 to 70 seconds.



LEGEND

1,2,3,............n	OBSERVATION VERTICALS
$b_1, b_2, b_3, \ldots b_n$	DISTANCE, IN FEET OR METERS, FROM THE INITIAL POINT TO THE OBSERVATION VERTICAL
$d_1, d_2, d_3, \ldots d_n$	DEPTH OF WATER, IN FEET OR METERS, AT THE OBSERVATION VERTICAL
– – – – –	BOUNDARIES OF SUBSECTIONS (HEAVILY OUTLINED AREA IS DISCUSSED IN TEXT)

SOURCE: GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2175, 1982

SKETCH OF MID-SECTION METHOD OF COMPUTING CROSS-SECTION AREA FOR DISCHARGE MEASUREMENTS
FIGURE 1

TABLE 1
NUMBER OF SUBSECTIONS BASED ON STREAM WIDTH

Approximate Width (feet)	Approximate Number of Subsections	Approximate Distance between Subsections (feet)
< 2	8 – 10	0.2 – 0.3
2 – 4	10 – 12	0.3 – 0.4
4 – 10	12 – 15	0.4 – 0.7
10 – 20	15 – 20	0.7 – 1.0
> 20	20 – 25	1.0 – 3.0

2.2.2 Required Measurement Conditions

In order to make a velocity-area discharge measurement, the following conditions are required:

- The stream must be channelized: that is, observable banks must channel the stream flow.
- Depth must be greater than 0.2-feet across most of the cross-section being measured.

- The stream must have measurable velocity of at least 0.2 feet per second (fps) in most of the cross-section, although the pygmy meter is capable of measuring velocity as low as 0.070 fps.

The first two conditions can often be met in streams of very low discharge by conservatively modifying the stream channel to produce a narrower and slightly deeper cross-section in order to meet measurement requirements. These modifications will include removal of aquatic growth or ice, moving large stones which impact velocity upstream or downstream of the cross-section, and narrowing or deepening of the cross-section. By rearranging small amounts of native rock or sand, the technician will produce a measurable cross-section. After thus clearing the cross-section, flow will be allowed to stabilize before the current-meter measurement of velocities begins.

Current meter measurements are best made by wading, if conditions permit. The Price AA, Pygmy, Swoffer, or Marsh-McBirney meters are used for wading measurements. Table 2, Current Meter and Velocity Method for Various Depths, lists the optimal type of meter and velocity method for wading measurements at various depths. A discussion of Table 2 follows the table.

TABLE 2
CURRENT METER AND VELOCITY METHOD FOR VARIOUS DEPTHS (ft)

Depth, in feet	Meter	Velocity Method (% of Depth)
1.5 – 2.5	Type AA or Swoffer	0.6
0.3 – 1.5	Pygmy or Swoffer	0.6
< 0.3	Pygmy or Swoffer	0.5

Some departure from Table 2 is permissible depending on the type of meter available. The type of meter used will be documented in the field logbook. In the 0.6-depth method, an observation of velocity made in the vertical at 0.6 of the depth below the surface is used as the mean velocity in the vertical. The 0.5-depth method will be used in very shallow stream conditions, with depths of less than 0.1 meters. This method requires that the meter be set at one-half the depth of water at the point, or at the lowest setting on the rod.

Vertical axis current meters do not register velocities accurately when placed close to a vertical wall. A Price meter held close to a right-bank vertical wall will under-register because the slower water velocity near the wall strikes the effective (concave) face of the cups. The converse is true at a left-bank vertical wall. (The terms "left bank" and "right bank" designate direction from the center of a stream for an observer facing downstream). The Price meter also under-registers when positioned close to the water surface or close to the streambed.

2.2.3 Equipment

Current meters, timers, depth and width measuring devices, and a means of counting meter revolutions are needed for measurement of discharge. The equipment includes:

- Depth-measuring device, the wading rod
- Current meter with digital read-out (or data logger)
- Width-measuring devices, either engineer's tape or tagline
- Stop watch

Depth-Measuring Device. The depth-measuring device that will be used is the topsetting wading rod. The current meter is attached to the wading rod. The top-setting wading rod consists of a main rod for measuring depth and a 3/8-inch diameter round rod for setting the position of the current meter.

Current Meter. A current meter is an instrument used to measure the velocity of flowing water. The principle of operation is based on the proportionality between the velocity of the water and the resulting angular velocity of the meter's rotor. By placing the current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

The number of revolutions of the rotor is obtained by an electrical circuit through the contact chamber. Contact points in the chamber are designed to complete an electrical circuit at selected frequencies of revolution. The contact chambers have contact points that will complete the circuit once per revolution. The electrical impulse is then digitally recorded. The intervals during which meter revolutions are counted are timed with a stop watch.

Engineer's Tape or Tagline. Steel tapes, metallic tapes, or premarked taglines are used for width determinations during discharge measurements made by wading. Orientation normal to the flow pattern of the river and elimination of most of the sag, through support or tension, are recommended for improved accuracy.

Stop Watch. A stop watch is used to measure time during which velocity is measured at each point in the cross-section. Velocity at each point is measured for a period greater than or equal to 40 seconds and less than or equal to 70 seconds.

2.2.4 Maintenance and Calibration Procedures

Prior to use of the current meter, spin tests will be conducted to ensure that the unit performs acceptably. The spin test will be performed in an enclosed area, such as in the cab of a truck, to prevent wind interference. The test is to be performed prior to attaching the current meter to the wading rod. While holding the meter steady in an area sheltered from breezes, the technician will spin the rotor and then press the start button on the stop watch. The technician will observe the meter until the rotor ceases to spin.

The duration of the spin for the pygmy or Swoffer meter should be more than 40 seconds and for the Price AA meter should be more than 90 seconds. If the meter fails to meet the time-of-spin criteria, the meter will be cleaned and oiled before use. If the meter continues to spin well beyond these time limits, the record will indicate that the meter spun for 40+ seconds, in the case of the pygmy or Swoffer meter, or for 90+ seconds, in the case of the Price AA meter.

To assure reliable observations of velocity, it is necessary that the current meter be kept in good condition. Before and after each discharge measurement, the meter cups or vanes, pivot and bearing, and shaft should be examined for damage, wear, or faulty alignment. During measurements, the meter will be observed periodically when it is out of the water to be sure that the rotor spins freely.

Meters will be cleaned and oiled daily when in use. If measurements are made in sediment-laden water, the meter will be cleaned immediately after each measurement. After oiling, the rotor will be spun to make sure that it operates freely. If the rotor stops abruptly, the cause of the trouble will be sought and corrected before using the meter.

In addition to meter maintenance, the entire unit, consisting of current meter, wading rod and digital counter will be checked before departure to the field each day.

2.2.5 Field Procedures

Overview. A Price AA meter, Swoffer meter, or equivalent, will be selected to perform a velocity-area measurement. Neither the type AA meter nor the Swoffer meter should be used for measuring velocities slower than 0.1 fps unless absolutely necessary. If depths or velocities under natural conditions are *too* low for a dependable current meter measurement, the cross-section will be modified, if practical, to provide acceptable conditions. A shovel will be used to remove aquatic vegetation, ice, or rocks, which may interfere with meter operation or discharge measurement.

At each measurement point (or station) across the stream cross-section, depth is measured prior to measurement of velocity. Therefore, it is recommended that the wading rod be set with the current meter suspended out of the water and above the tagline, which is used to measure width and to identify stations across the cross-section. Placement of the rod about 0.5-feet downstream from the tagline prevents contact between the tagline and the current meter when the meter is lowered into measuring position.

The wading rod will be placed in the stream so the base plate rests on the streambed, and the depth of water will then be read from the graduated main rod. The main rod is graduated into 0.1-foot increments: these increments are indicated by a single score in the metal. Increments of 0.5-foot are marked by two scores in the metal, and one-foot increments are marked by three scores in the metal. A vernier scale on the upper handle of the rod corresponds to 0.1-foot increments, and has 1 through 9 in raised numbers next to raised marks. A sliding, adjustable rod, known as the setting rod, to which the meter is attached, has single scored marks which are aligned with values on the vernier scale.

The hydrographer reads water depth directly from the main rod. In high velocity areas, it is recommended that depth be read as the value between the depth on the upstream side of the rod and the depth on the downstream side of the rod. Depth is measured to the nearest 0.1-foot. This depth is used to set the vertical location on the current meter.

The setting rod is next adjusted downward so that the scored mark of the setting rod which corresponds to the range of depth in 0.1 meters (e.g., if depth = 0.46, range in feet = 0; or if depth = 1.23, range in feet = 1) is aligned with the stream depth value transposed to the vernier scale. This automatically positions the meter for use in the 0.6 method as the meter is then six-tenths of the total depth from the surface of the water. If depths are less than 0.3-feet, the 0.5 method may be used. The observation depth recorded will then be 0.5 of the total depth.

The hydrographer will stand in a position that least affects the velocity of the water passing the current meter. That position is obtained by facing upstream while holding the wading rod vertically and close to the tagline or measuring tape. The hydrographer stands at about a 45-degree angle downstream from the wading rod and at least 1.5-feet meters from the wading rod. This angle is an imaginary angle between the extended arm holding the wading rod and the tagline or measuring tape. The hydrographer should avoid standing in the water if his or her feet and legs occupy a significantly large percentage of a narrow cross-section. For narrow streams, it is often possible to stand astride the stream.

The wading rod should be held in a vertical position with the meter parallel to the direction of flow while the velocity is being observed. When measuring streams that have shifting beds, the soundings or velocities can be affected by the scoured depressions left by the hydrographer's feet. For such streams, the meter should be placed ahead of and upstream from the hydrographer's feet.

Once the velocity-area measurements have all been taken, measure and record the gage height from the staff gage to the nearest 0.02-foot again.

<u>Steps to be Followed in Measuring Discharge.</u> Water quality and bed material samples will be collected prior to making discharge measurements. The following steps are to be followed in discharge measurement:

- Use the staff gage to measure and record the gage height to the nearest 0.02 of a foot.

- Measurement notes are recorded on the Surface Water Data Collection Form at each subsection of the cross-section as the measurement is performed.

- If two people are performing the measurement, the hydrographer may state the stations, depths, counts, and number of seconds to a note keeper. The note keeper would then repeat each value stated by the hydrographer to assure agreement between the value stated by the hydrographer and the value heard by the note keeper.

- Record on the field data collection form the following: distance from initial point, width, depth, observation depth, revolutions, time in seconds, velocity, area, discharge.

- Note the distance in meters in terms of stream direction that this cross-section lies from the prescribed location. For example, the note may read "25 feet downstream" or "15 feet upstream." This is recorded in a manner similar to that on the front of the discharge measurement note.

- If the selected cross-section contains aquatic growth, ice, boulders, or slack-water areas that can either interfere with operation of the current meter or otherwise impede accurate measurement, use a shovel to remove minor flow impediments.

- Position a tape (for small streams) or the tagline (for large streams) about one-foot above the surface of the water. Secure the tape so that it remains taut and perpendicular to the channel.

- Select a starting point at either the left bank (left edge of water, LEW) or the right bank (right edge of water, REW), which is determined by facing downstream.

- Measure the width of the stream in meters. Select the number of subsections in which to measure velocity. The goal in selection of measurement stations is to measure no more than ten percent of the total discharge in any given subsection. Subsections need not be identical in width. Use more observation points in deep areas or portions of the channel having higher velocities. Frequently, fewer observation points are needed near the shore than near the center of the stream. Obvious breaks in streambed configuration are also proper locations at which to measure velocities.

- After determining the distance desired between stations, measurement can begin. Record the time and bank at which measurement starts on the discharge measurement note as "REW Start 0000", using REW or LEW, depending upon whether starting at the right or the left edge of the water. 24-hour clock time is used, and is recorded to the nearest five minutes.

- Note the distance to the beginning edge of water from the initial point. The initial point is an arbitrary point on the tape, preferably a whole number, which lies on the shoreside of the stream. All subsequent station locations are recorded as distances from the initial point.

- Proceed to the first station. Record the distance from the initial point on the discharge note.

- Stand downstream of the tagline or tape and face upstream. Begin with the current meter on the wading rod well above the surface of the water.

- Measure stream depth at the measurement point on the wading rod. Individual lines on the wading rod indicate 0.1-foot increments; double lines indicate 0.5-foot increments, and triple lines indicate one-foot increments. Record the stream depth to the nearest 0.02-foot: for example 0.31 feet or 1.54 feet.

- Lower the meter to the required depth and record the observation depth in the logbook. The observation depth as a fraction of total depth is usually 0.6, or 0.5 for subsections having depth of less than 0.3 feet.

- Stand downstream of the meter with the arm fully extended as you hold the wading rod. Position yourself so that the angle measured between the arm and the tagline is about 45 degrees. Stand as far away from the vertically held wading rod as possible.

- Start the stopwatch.

- After at least 40, but as much as 70 seconds have passed, stop the stopwatch.

- Record velocity displayed on digital read-out on same line of the note as the depth.

- Proceed to the next station. Record the distance from the initial point to the station. Repeat measurements of depth and velocity. Continue in this manner across the stream.

- After recording the distance measurement at the last station, record the time at which the ending edge of water is reached as "LEW (or REW) FINISH 1330."

- Note velocity and depth at the edge of water as zero.

- Following velocity-depth measurements, use the staff gage again to measure and record the gage height to the nearest 0.02 of a foot.

- Evaluate and record on the data collection note the following: flow characteristics, weather, air temperature, water temperature, observer(s), type of meter, and remarks.

2.2.6 Discharge Calculations

A stream discharge is the summation of the products of the subsection areas of the stream cross-section and their respective average velocities. The formula Q = S(av) represents the computation, where Q is the total discharge, a is an individual subsection's area, and v is the corresponding mean velocity of flow normal to the subsection. The summation of the discharges for all the subsections is the total discharge of the stream. The order for calculating discharge is:

- Use the distances from initial point to compute width for each section. The first width is computed by subtracting the first distance from the second distance, and dividing this quantity by two. The second width will be the quantity of difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the distance on the line above the line you are calculating from the distance on the line below the line you are calculating, and divide this quantity by two. This procedure is carried out for each line until you reach the final width calculation. This is calculated as the quantity of the difference between the final distance and the second-to-the-last distance, divided by two.

- Subsequent calculations will be performed as follows:

  < Calculate each discharge for each subsection by multiplying the width of the subsection times the depth times the velocity.

  < Sum the discharges for each subsection to arrive at total discharge for the entire cross-section.

- Check your math by summing the subsection widths. Their total should equal the value obtained by taking the difference between the LEW and the REW station distances from initial point.

- Initial at the line "Comp. by" to identify yourself as the person responsible for performing the discharge calculation.

2.3 VOLUMETRIC METHODS

The volumetric method is a simple and accurate method for measuring flow from small discharges such as gravity flow discharges from pipe outlets.

2.3.1 Theoretical Considerations

This method involves measuring the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume. Alternatively, in the case of measuring discharge remotely in a sump or standpipe setting, the volumetric method may be performed by capturing flow in a container for a set period of time.

2.3.2 Required Measurement Conditions

Conditions must be such that all discharge from an outlet can be captured in the volumetric container during the period of measurement.

2.3.3 Equipment

The bucket and stop watch technique is particularly useful for the measurement of small flows. Equipment required to make this measurement is a calibrated container and a stopwatch. Calibrated containers of varying sizes will include:

- 5-gallon bucket
- 2-liter graduated cylinder
- 1-liter graduated cylinder
- 1-liter bucket
- 500-milliliter beaker
- 250-milliliter beaker

2.3.4 Maintenance and Calibration Procedures

Graduated cylinders are incremented in terms of milliliters and can be easily converted to gallons. The incremental volume of a 5-gallon bucket can be determined by adding known volumes of water and recording the depth after each addition.

2.3.5 Field Procedures

Upon arrival at the site, the sampling personnel will evaluate the flow conditions to select the appropriate method for flow measurement. If flow conditions are appropriate for volumetric measurement, the sampling personnel will observe and use judgement in approximating the flow volume and will select an appropriately sized volumetric container.

Sampling personnel will use a stopwatch to measure the time required to fill a volumetric container. Three consecutive measurements will be made and noted, and the results will be averaged to determine the discharge.

2.3.6 Discharge Calculations

Discharge will be determined initially in gallons per second (gal/s) or in milliliters per second (ml/s). These values will be noted, but the average value will be reported in cubic meters per second. Calculations will be performed as follows:

- Record each of the three measurements in terms of gallons per second or milliliters per second, depending on the volumetric container.

- If one of the three measurements is 50 percent or more different from the other two measurements, then this value will not be used. Instead, three additional measurements will be taken and, provided that none of these three measurements differs by greater than 50 percent from the other two measurements, these values will be used.

- Average the three values.

- Convert the averaged value to cfs as follows:

  - To convert ml/s to cfs, multiply by 3.5×10^{-5}
  - To convert gal/s to cfs, multiply by 0.134

- Record discharge in cfs (gpm for seeps, springs and low-flow pipes).

3.0 REFERENCES

Rantz, S.E., et al. Measurement and Computation of Streamflow: Volume I and II; Measurement of Stage and Discharge; Computation of Discharge. Geological Survey Water-Supply Paper 2175. U.S. Government Printing Office. Washington, D.C. 1982.

U.S. Department of the Interior. National Handbook of Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, Geological Survey. Reston, VA, 1977.

U.S. Department of the Interior. Hydraulic Measurement and Computation: "Discharge Measurements at Gaging Stations." Book 1, Chapter 11, Geological Survey. Reston, VA. 1965.

ATTACHMENT

FIELD DATA SHEETS

SURFACE WATER DISCHARGE FORM

DIST FROM INITIAL POINT	WIDTH (ft)	DEPTH (ft)	OBSER DEPTH	REVS	VELOCITY (M/S)		AREA (ft^2)	DISCHARGE (cfs)
					TIME (SEC)	AT POINT		
	REW or LEW (circle one) at time =							
	REW or LEW (circle one) at time =							

REW = Right Edge of Water (viewed downstream)
LEW = Left Edge of Water (viewed downstream)

Signature of Field Personnel ____

STANDARD OPERATING PROCEDURE

SOP-4

GROUNDWATER LEVEL MEASUREMENT

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this technical procedure is to establish a uniform and consistent procedure for measuring water levels in wells, piezometers and boreholes.

The groundwater level measurement procedures presented in the following sections were developed using standard industry-accepted practices, as well as international organization and agency guidelines and standard practices. The same care must be exercised in implementing field investigations and sampling events that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada (U.S.) Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)

2.0 DEFINITIONS

2.1 ELECTRIC WATER LEVEL SOUNDER (EWS)

An electronic water-level sounder (EWS) is an instrument for measuring water levels in wells, piezometers and boreholes. An EWS is essentially an open circuit involving an ammeter and battery mounted on a reel to which an insulated two-wire electric cord (calibrated by length) is wound. The circuit is closed, and a buzzer sounds when the electrodes on the probe are immersed in water. Depth to water is recorded at the depth where the buzzer sounds.

3.0 DISCUSSION

Measurement of static water levels may constitute a separate task or be performed in conjunction with groundwater sampling. Prior to any purge sampling activity at each monitor well, a water level measurement is required to be taken. Measurement of the static water level is important in determining the hydrogeologic characteristics of the groundwater system.

Prior to taking the EWS to the field, check that the EWS is functioning properly and that the batteries are in working order by turning instrument on and pushing the test button located on the side of the instrument. Also verify that the probe is functioning properly by submerging it in tap water. Both the audio and visual signals should function.

Decontaminate the probe and cord of the EWS using Alconox or equivalent non-phosphate detergent and distilled water. Rinse a minimum of three (3) times with distilled water. At a minimum decontaminate the probe and the length of reel you believe will be in the well plus an additional 3 meters.

The measurement will be referenced from the reference point marked on the top of the well casing; this is typically located on the north side of the casing. The measurement to the static water level in the well will be to the nearest 0.01-foot interval. The measurement will be immediately repeated to verify the accuracy of the initial reading. The depth to water measurement will be compared in the field to previous measurements to verify that the measurement is reasonable. Record the depth to water level on the field logbook and Record of Water Level Readings form (see Attachment). Other items to record include well identification number, casing diameter, vertical height of measuring point above ground surface, and time and date of measurement.

If depth to water is measured in an open borehole, note that the reference level is ground surface. Also note, especially if the ground is uneven, from which side of the borehole (i.e. north, etc.) the measurement was referenced.

In addition, it is good practice to periodically measure total well depth, since silt can build up and decrease the total depth of the well. Measure the total depth of the well following determination of static water level. If using the EWS to determine the depth of the well, make sure that the additional cable that will be submerged has been decontaminated and that the probe tip length is added to the total depth measured. Total well depth measurement also ensures that the well is in good condition to total depth.

4.0 EQUIPMENT AND MATERIAL

The following is a list of equipment that should be available in the field to perform water level measurements.

- Electric Water-level Sounder or Measuring Tape with a Wetable Surface
- Folding Rule
- Field logbook or field data sheet (see Record of Water Level Readings form, found in Attachment)
- Data on Well Identification Number and Locations
- Spare Battery for Electric Water-level Meter
- Permanent, waterproof pens

5.0 PROCEDURES

- Record well identification number and measuring device type and serial number.
- Each water level sounder or measuring tape used for recording water levels should have the depth graduations checked with an independent folding rule or measuring tape for calibration prior to field use.
- Clean all downhole instruments and equipment before and after measurements between wells. Cleaning should be with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic free distilled or deionized water.
- Measure and record distance from ground level to top of casing or standpipe. Measure the vertical distance from the top of casing or standpipe to the point of the elevation survey mark (if different from top of casing or standpipe).
- If an EWS is used, turn on the EWS, check the battery, lower the wire into the borehole or standpipe and stop at the depth where the EWS meter indicates a repeatable, completed circuit. Record the length of the wire below the casing collar or top of the standpipe to the nearest 0.01-foot.
- If a measuring tape is used, lower the tape (with a weight attached) into the borehole. The tape must be lowered a sufficient depth into the well to ensure the wetable surface section of the tape is partially submerged. The total length of the tape within the well (from the top of casing or standpipe) and the length of the wetted surface to the submerged end of the tape will be recorded.
- Record date, time, well designation, measuring device and all measurements on a Record of Water Level Readings form (Attachment), and bound logbook. The personnel making the measurement will initial or sign each measurement recorded. All water level measurement records will be maintained in the project records files.

6.0 REFERENCES

American Society of Testing and Materials (ASTM). 1994. *Standards on Ground Water and Vadose Zone Investigations.* Second Edition. ASTM Committee D-18 on Soil and Rock. Philadelphia, Pa.

American Society of Testing and Materials (ASTM), 1995. *ASTM Standards on Environmental Sampling*. PCN-03-418095-38, Philadelphia, Pa.

U.S. Environmental Protection Agency (EPA), 1994. *Standard Operating Procedures for Field Sampling Activities, Version 2*. EPA Region VIII, Denver, Colorado.

U.S. Environmental Protection Agency (EPA), 1995. *Standard Operating Procedures for Water Level and Non-Aqueous Phase Liquid (NAPL) Measurements in Boreholes and Monitoring Wells, Version 1.* EPA Region VIII, Denver, Colorado.

ATTACHMENT

RECORD OF WATER LEVEL READINGS

RECORD OF WATER LEVEL READINGS

Job No. ___________________ **Project No.** _______________________ **Location** __________________

Borehole No.	Date	Time	Measuring Device	Reading	Corrections Or Conversions	Water Level	Surf. Elev.	Water Level Elev.	By	Comments

Signature of Field Personnel ______________________________________

STANDARD OPERATING PROCEDURE

SOP-5
COLLECTION OF NEAR-SURFACE SOIL SAMPLES

TABLE OF CONTENTS

1.0 INTRODUCTION

This standard operating procedure (SOP) describes methods and equipment commonly used for collecting environmental samples of near-surface soil and mine waste material media for either on-site examination and chemical testing or for laboratory analysis. It also describes procedures for sample handling, labeling and documentation.

The information presented in this SOP is generally applicable to all environmental sampling of near-surface soil and mine waste material except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions, and equipment different from those described herein.

Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Every field investigation must be conducted in accordance with an approved quality assurance project plan (QAPP). The QAPP identifies the minimum procedures required to assure that goals for precision, accuracy, completeness, representativeness, and comparability of data generated are satisfied. In addition to the QAPP, every field program must have a site-specific field sampling plan (FSP) that defines the proper procedures to be followed in the collection, preservation, identification and documentation of environmental samples and field data.

The same care must be exercised in implementing field investigations and sampling programs that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada (U.S.) Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)
- U.S. Department of the Interior, Geological Survey (USGS)

2.0 DEFINITIONS

Surface soil: The soil that exists down from the surface approximately one foot (12-inches). Depending on application, the soil interval to be sampled will vary.

Grab Sample: A discrete portion or aliquot taken from a specific location at a specific point in time.

Composite: Two or more subsamples taken from a specific media and site a specific point in time. The subsamples are collected and mixed, then a single average sample is taken from the mixture.

Spoon/Scoop: A small stainless steel or Teflon utensil approximately 6- to 8-inches in length with a stem-like handle.

Trowel: A small stainless steel or Teflon shovel approximately 6- to 8-inches in length with a slight curve across the blade. The trowel has a stem-like handle. Samples are collected with a spooning action.

3.0 SAMPLING PROCEDURES

3.1 BACKGROUND

Near-surface soil and mine waste material samples are collected to determine the type(s) and level(s) of contamination. These samples may be collected as part of an investigation plan, site-specific sampling plan, and, or as a screen for "hot spots", which may require more extensive sampling. Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically, the top one-inch of material, including vegetation, are carefully removed before collection of the sample.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important element not only for assessment and quantification of environmental impact to, or posed by, the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a representative sample has been taken. To collect representative samples, sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification must be minimized.

3.2 DEFINING THE SAMPLING PROGRAM

Factors that shall be considered in developing a sampling program for near-surface soil include study objectives; accessibility; site topography; physical characteristics of the medium; point and diffuse sources of contamination; and personnel and equipment available to conduct the investigation(s).

3.3 SAMPLE COLLECTION

The following steps must be followed when preparing for sample collection:

- The collection points shall be stated, located on a map, and referenced in the field logbook.
- Processes for verifying depth of sampling must be specified in the site-specific field sampling plan.
- Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place decontaminated equipment to be used on the plastic. Cover all equipment and supplies with clean plastic sheeting when not in use.
- A clean, decontaminated trowel, scoop, or spoon will be used for each sample collection.

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Hand auger
- Trowel
- Scoop or spoon
- Back-hoes
- Drill rigs

A trowel, scoop/spoon or hand auger are used most often.

The criteria for selecting a sampler include:

- Ease of disposal and, or decontamination.
- Relative expense (if the item is to be disposed of).
- Ease of operation, particularly if personnel protection required is above Level D.
- Reactivity/contaminating potential - Stainless steel, Teflon, or polyethylene sampler are preferred (in that order). Back-hoes may be used to collect samples from shallow trench walls; the bucket must be free of rust, grease and point. Only soil which has not been in contact with the bucket may be sampled.

3.3.1 Saturated Soil Paste

Saturated soil pastes are used in to field characterize soil medium Paste pH indicates the degree of acidity or alkalinity in soil materials. Paste conductivity indicates the total concentration of ionized constituents of soil extract solutions. These measurements will be useful in determining the solubility of soil minerals, the mobility of ions in the soil, potential soil toxicity and assessing the viability of the soil-plant environment.

The following procedures will be used to prepare and measure saturated soil pastes in the field environment.

- Identify a minimum of three sub-samples of the soil material of interest.
- Collect approximately two (2) pounds of soil material (0 to 12-inch depth) at each sub-sample location and composite into a large, decontaminated stainless steel mixing bowl or high-density polyethylene (HDPE) bucket.
- Prepare a composite sample by thoroughly mixing the sub-sample material.
- Fill a 250 millimeter (ml) beaker with 100 ml of the sample.
- Add distilled water to the sample (approximately ¼ to ½ the volume of the soil sample) while stirring the mixture with a decontaminated stainless steel spatula (or equivalent).
- At saturation the soil paste glistens as it reflects light, flows slightly when the container is tipped, and the paste flows freely and cleanly of the stirring apparatus. If excess water has been added to the sample, add small amounts of additional soil with mixing to absorb the excess water.
- After mixing, the sample should be allowed to stand for a minimum of one (1) hour.
- The pH of the paste is measured directly by slowing inserting the pH probe into the paste and waiting for the reading to stabilize.
- To determine the conductivity of the paste:
  - set up a vacuum filter apparatus (e.g., peristaltic pump) with a 0.45 micron disposable filter;
  - use the vacuum device to separate the liquid filtrate from the paste, collecting the filtrate in a collection beaker;
  - collect approximately 25 ml of filtrate;

   - measure the conductivity of the filtrate by placing the conductivity probe directly into the filtrate and waiting for the reading to stabilize.
- Record the values in the field notebook.

3.3.2 Direct Collection

The following procedure will be used to collect near-surface soil and mine waste material samples.

- Identify a minimum of three sub-samples of the soil material of interest.

- Collect approximately two (2) pounds of soil material (0 to 12-inch depth) at each sub-sample location and composite into a large, decontaminated stainless steel mixing bowl or high-density polyethylene (HDPE) bucket.

- Prepare a composite sample by thoroughly mixing the sub-sample material.

- Fill the pre-labeled sample container the composited material.

- Upon completion of the sampling, the excess material removed from the hole and not used as sample will be used to backfill the hole.

- After each composite sample is obtained, all equipment used in the sampling process, including shovels, trowels, spoons, and bowls will be decontaminated prior to reuse.

3.3.3 Decontamination of Field Equipment

The sample collection equipment will be decontaminated at each monitoring location. The following guidelines will be used to decontaminate sampling equipment:

- Gross contamination on equipment will be scraped off at the sampling site.

- Equipment that will not be damaged by water will be washed with the Alconox (or a comparable non-phosphate), biodegradable detergent. Equipment will be triple rinsed with potable water followed by a triple distilled or de-ionized water rinse.

- Equipment that may be damaged by water will be carefully wiped clean using a sponge and detergent water, and rinsed with distilled or de-ionized water. Care will be taken to prevent any equipment damage.

- All non-dedicated equipment will be decontaminated between each sample location. When purging groundwater monitoring wells, meter probes will be rinsed with distilled or de-ionized water between each casing volume measurement. After collecting the sample follow the full decontamination procedures.

- Rinse and detergent waters will be replaced with new solutions between sampling events.

Following decontamination, equipment will be placed in a clean area or in clean plastic bags to prevent contact with soils/sediments and airborne material that could contaminate a future sample.

4.0 SAMPLE HANDLING AND FIELD DOCUMENTATION

The purpose of this section is to define the standard protocols for sample handling, documentation and chain-of-custody. The use of proper documentation and chain-of-custody procedures will assure that the adequacy of the sample collection methods and handling can be evaluated.

4.1 SAMPLE HANDLING

4.1.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, sample bottles will be obtained directly from the analytical laboratory, or laboratory supply-house. The bottles will be labeled (see following section) to indicate the type of sample and sample matrix to be collected. Sample bottles can be either pre-preserved from the laboratory or preservatives can be added in the field during sample collection. In general, 0.5-liter or 1-liter polyethylene or glass bottles will be used for the sample bottles that will be submitted for analysis of general chemical constituents, major inorganic constituents and metals.

Laboratory sample containers will be filled one by one at the monitoring location, secured with the container lid, and any excess soil wiped off the exterior. Immediately after collection, the containers will be placed in field coolers with ice. Glass containers will be wrapped with bubble wrap or other appropriate shipping material to prevent breakage.

4.1.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to assure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping. Sample preservation requirements are based on the most current publication of 40 CFR, Part 136.3 (U.S. Federal Register).

For all samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

4.1.3 Sample Holding Times

Sample holding times are established to minimize chemical changes in a sample prior to analysis and, or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and, or extraction, based on the nature of the analyte of interest and chemical stability factors.

In general, soil or solid matrices do not have holding times. However, most samples will be shipped to the analytical laboratory in iced coolers within 48 hours of collection, if conditions permit**.**

4.1.4 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described above, and placed on ice in an insulated cooler. The sample containers should be placed in re-sealable plastic storage bags. Samples should be stored in an upright position. Coolers sent to the analytical laboratories should be chilled with ice. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to assure that the cooler cannot be opened without breaking the seal.

4.2 FIELD DOCUMENTATION

Documentation establishes procedures, identifies written records, enhances and facilitates sample tracking, standardizes data entries, and identifies and establishes authenticity of the sample data collected. Proper documentation also:

- Assures that all essential and required information is consistently acquired and preserved;
- Documents timely, correct, and complete analysis;
- Satisfies quality assurance requirements;
- Establishes chain-of-custody;
- Provides evidence for court proceedings; and,
- Provides a basis for further sampling.

4.2.1 Sample Labels

Samples collected will be identified by a sample tag attached to the sample bottle. A sample tag or label will be completed and attached to each laboratory sample container just before it is filled. The labels will be filled out with a permanent marker and will include the following information:

- Sample identification
- Sample date
- Sample time
- Sample preservative (if any)
- Sample type (including if raw or field filtered)

Because a variety of preservatives and analytical methods will be employed, care must be taken to avoid mislabeling the containers. If possible, labels should be covered with plastic tape to minimize smudging and ink runs.

4.2.2 Sample Identification

Each sample will be given a unique identification number. This number will identify the date of sampling, sample matrix, the location identification number, and, if appropriate, a quality control suffix. To avoid confusion between primary samples and quality control samples, duplicate samples will be designated with a "D", triplicate samples will be designated with a "T", field blank samples will be designated with a "B", and equipment blanks will be designated with a "E" suffix in the station identification name. For example:

station identification number-quality control suffix

SW-2-D

The above sample identification represents a soil <u>duplicate</u> sample collected at SW-2.

4.2.3 Field Documentation

Appropriate field records will be completed in a bound field logbook and, or field data sheets at each site at the time of sample collection. All aspects of sample collection and handling as well as visual observations will be documented in the field logbooks. In general, field logbooks as well as field data records should:

- Record, identify and describe all pertinent sampling and monitoring activities.

- Record quantitative and qualitative information for each sample collected.
- Record and describe all field team activities, including observations and events.

At a minimum, the following information will be recorded in the field at each monitoring station:

- Site location
- Sampler name(s)
- Date and time of sample collection
- Sample identification number(s)
- Type of sample (soil, mine waste material, sediment)
- Field measurements, if applicable (paste pH and conductivity)
- Sample handling
- How sample collected (e.g. grab, composite)
- Number and type of any QA/QC samples collected
- Sample depth
- Weather conditions, including recent precipitation and approximate air temperature
- Field observations, including any unusual conditions or activities in the area

Changes or deletions in the field logbook should be lined out with a single strike mark and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory. All field notebooks and data forms will be signed at the end of each day.

4.2.4 Chain-of-Custody

A chain-of-custody (COC) record is used to record the custody and transfer of all samples. The field sampler will be responsible for the care and custody of the water quality samples until they are transferred to a licensed courier. The sampler's responsibility will include:

- Labeling and sealing all sample containers (including custody seals, when appropriate);

- Properly packing the samples with ice for shipment to the laboratory;

- Notifying the courier about a sample pick-up and preparing any airbills for shipping samples to the laboratory;

- Initiating chain of custody forms; and,

- Notifying the laboratory of all sample shipments.

A chain-of-custody form will accompany each sample cooler and include the following information.

- Project name or number
- Sampler's name and signature
- Sample identification number(s)

- Date and time of sample collection
- Sample matrix
- Number of sample containers
- Analyses requested

- Method of shipment (with airbill number if applicable)
- Any additional instructions for the laboratory

Upon receipt, laboratory personnel will inspect the samples and record their condition and temperature on the chain-of-custody form. The laboratory will immediately report the presence of broken custody seals to MWH's project laboratory liaison. The laboratory liaison, after consulting with the Project Manager and the laboratory's project manager, will decide whether or not to analyze the samples. Decision criteria that will be used to help in determining if the samples should be analyzed include:

- If the cooler custody seal is broken is there any sort of documentation that may indicate who broke the seal, e.g., a customs declaration, or a notation from the shipping company;

    - ➢ The samples can be analyzed

- If the cooler appears intact, and the samples inside are ok, e.g., the individual bottle custody seals are intact;

    - ➢ The samples can be analyzed

- If the cooler custody seal, and the individual bottle seal(s) have been compromised;

    - ➢ Then the samples <u>should not</u> be analyzed

The COC forms will be completed by the laboratory and forwarded with the final laboratory results.

5.0 REFERENCES

American Society for Testing Materials (ASTM), 1995. *ASTM Standards on Environmental Sampling*. Philadelphia, PA.

U.S. Environmental Protection Agency (EPA), 1994a. *U.S. EPA Region VIII Standard Operating Procedures of Field Sampling Activities, Version 2*. June. Denver, CO.

U.S. Environmental Protection Agency (EPA), 1996. *Compendium of Standard Operating Procedures for the California Gulch CERCLA Site, Leadville, Colorado. Revision 0.0.* April.

U.S. Environmental Protection Agency (EPA), 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.* U.S. EPA Region 4, Athens, GA. November.

APPENDIX E

WELL REPORTS AND BORING LOGS FOR PERRY CANYON MONITORING WELLS

Well Log: Lithology & Construction

Well Ident	Name
MWPC-1	**Perry Canyon Background Well**

Drill. Method		Drill. Dates	
Rotary		10/15-17/2002	

X (UTM)	Y (UTM)	Z (ft)	Meas. Pt. Elev.
278940	4413753	5150.0	5150.0

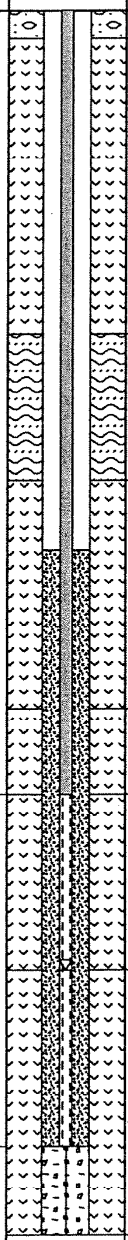
All measurements are in feet. Hole and casing diameters in inches.

Scales (1: xxx)

Water Level (ft AMSL)
5095.00

Vertical	Horizontal
120.0	30.0

Depth [feet]	Hole	Annulus	Casing	Screen		Lithology	Elev. [feet]
					1.5	Gravelly Sand, Alluvium, tan, loose, rounded	
5							5145
10						Tuff, welded, tan-gray, qtz, plag+kspar, biotite	5140
15		Cement/Bentonite					5135
					18.5		
20							5130
						Sandy Clay, Red, Wet, Soft	
25							5125
					27		
30		31					5120
			2			Tuff, Red-brown-orange, plag+kspar, qtz, FeOx	
35	8						5115
40					40		5110
						(Fractured Rock Easier Drilling)	
45				45	45		5105
		Sand Pack					
50						Ash Flow Tuff, lt. gray, homogeneous, no FeOx	5100
55					55		5095
60							5090
						(Hole Collapses @ 65')	
65		65	65	65			5085
		Backfill					
70	70	70			70		5080



Well Log: Lithology & Construction

Well Ident: **MWPC-2**	Name: **Perry Canyon Well Below Crown Prince Adit**
Drill. Method: **Rotary**	Drill. Dates: **10/17-18/2002**

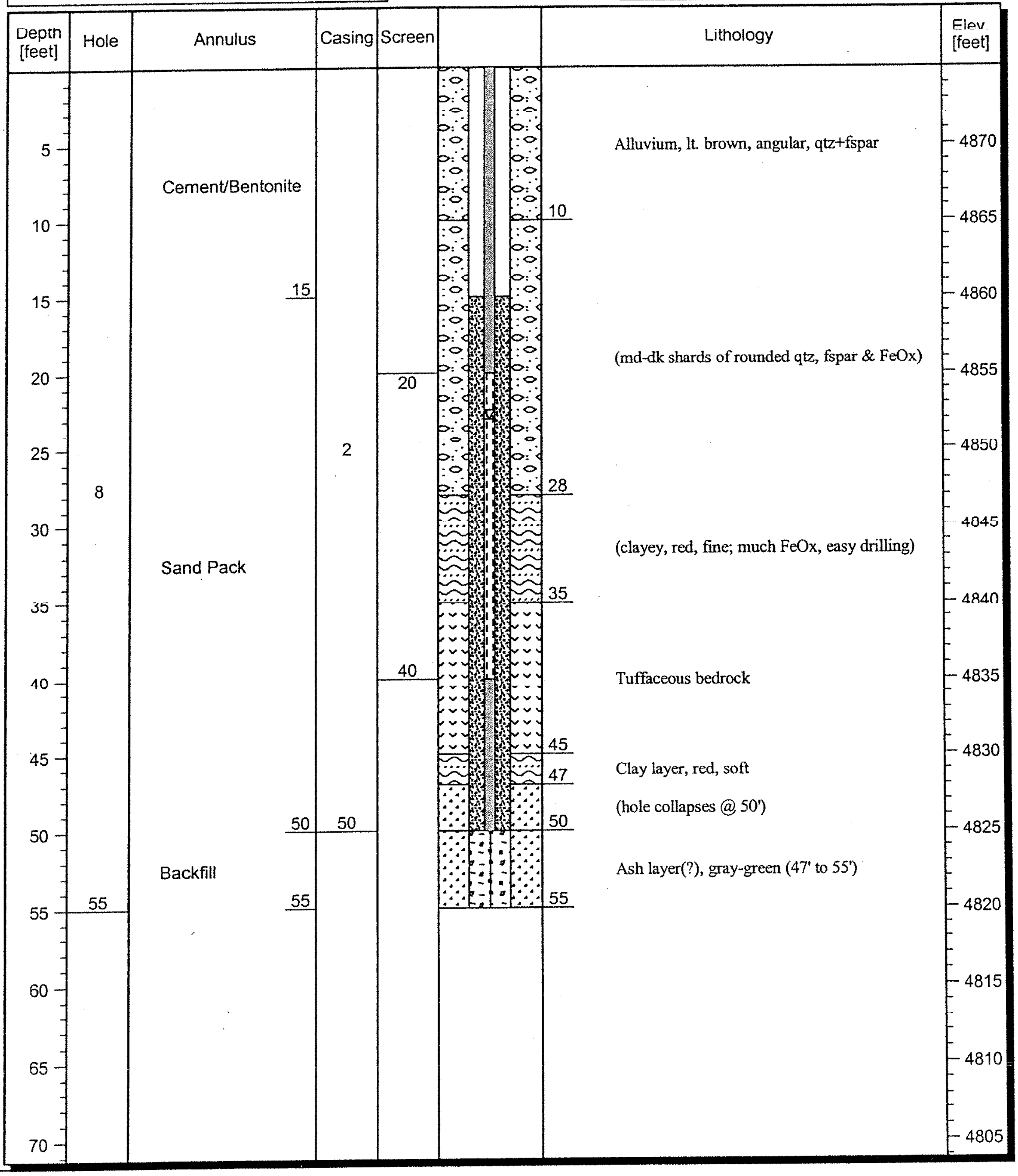
X (UTM)	Y (UTM)	Z (ft)	Meas. Pt. Elev.
277813	4414172	4875.0	4875.0

All measurements are in feet. Hole and casing diameters in inches.

Water Level (ft AMSL): **4852.00**

Scales (1: xxx)

Vertical	Horizontal
120.0	30.0



Well Log: Lithology & Construction

Well Ident	Name
MWPC-3	Perry Canyon Well Below Jones Kincaid Adit

Drill. Method	Rotary	Drill. Dates	10/18-21/2002

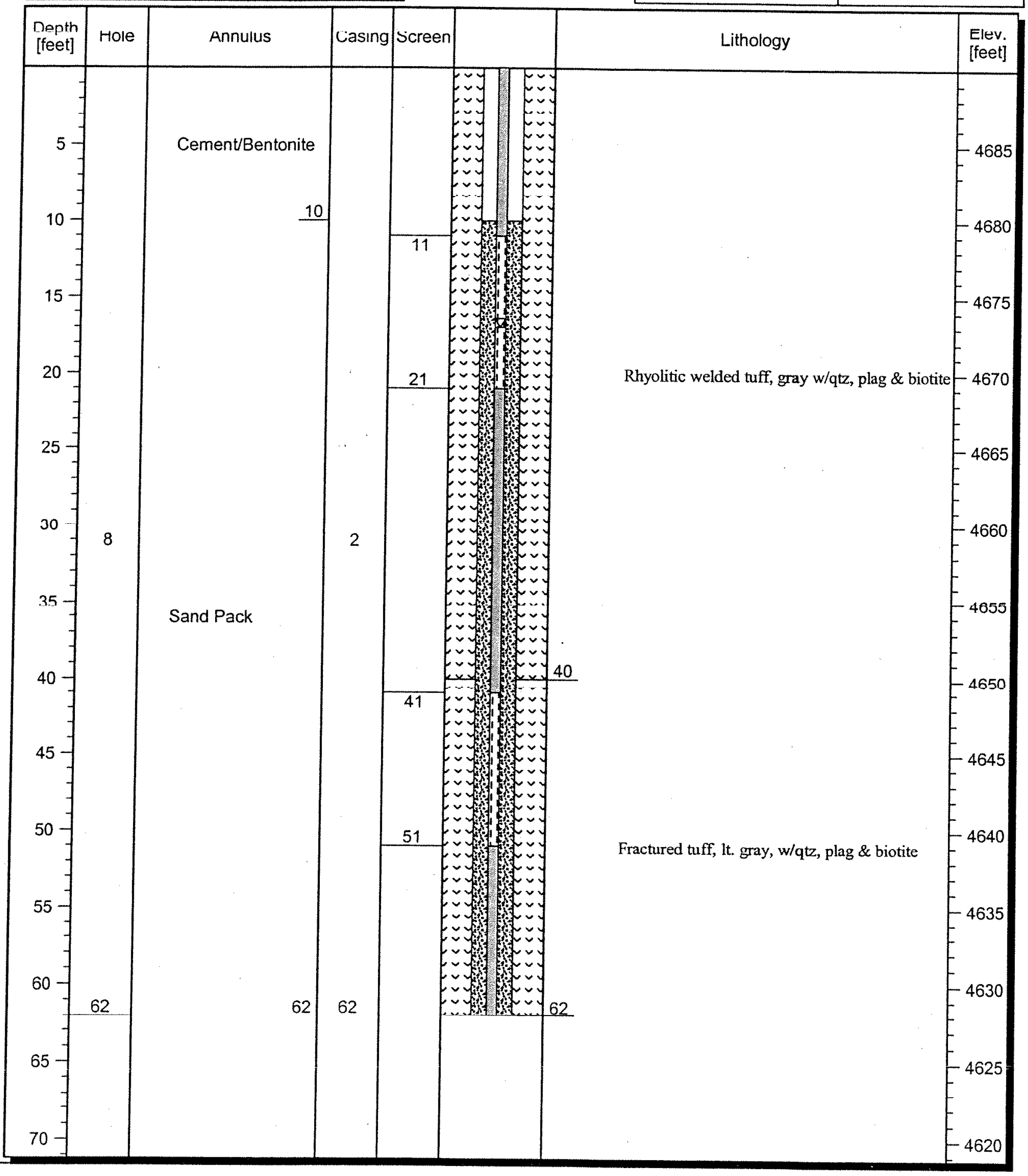
X (UTM)	277333	Y (UTM)	4414721	Z (ft)	4690.0	Meas. Pt. Elev.	4690.0

All measurements are in feet. Hole and casing diameters in inches.

Scales (1: xxx)

Water Level (ft AMSL)
4673.00

Vertical	Horizontal
120.0	30.0



Well Log: Lithology & Construction

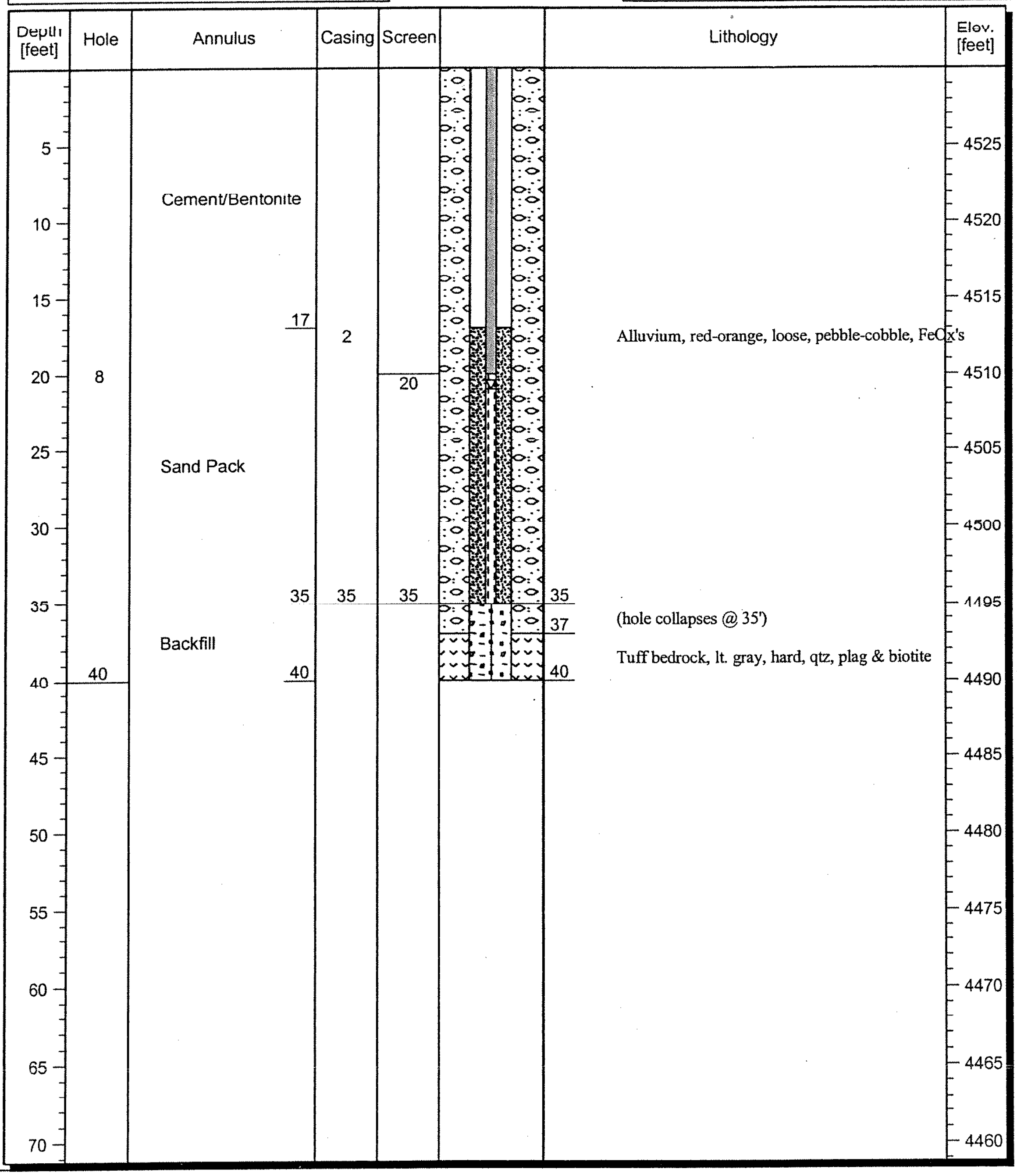
Well Ident	Name
MWPC-4	Well Near Mouth of Perry Canyon

Drill. Method	Rotary	Drill. Dates	10/21/2002

X (UTM)	276910	Y (UTM)	4415414	Z (ft)	4530.0	Meas. Pt. Elev.	4530.0

All measurements are in feet. Hole and casing diameters in inches. ***Scales (1: xxx)***

Water Level (ft AMSL)	Vertical	Horizontal
4509.00	120.0	30.0



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STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No ______
Permit No ______
Basin ______

NOTICE OF INTENT NO 48195

1.OWNER Bureau of Land Management ADDRESS AT WELL LOCATION PERRY CANYON

MAILING ADDRESS 5665 Morgan Mill Rd Carson City NV 89701 . 2.

LOCATION SE 1/4 NE 1/4Sec 23 T 23 N/S R 21 E County WASHOE

PERMIT NO. ______ ______ ______
Issued by Water Resources — Parcel No. — Subdivision Name

3. WORK PERFORMED
X New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Abandon ☐ Other ______

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial X Monitor ☐ Stock

5. WELL TYPE
☐ Cable X Rotary ☐ Rvc
X Air ☐ Other ....

6. LITHOLOGIC LOG

MATERIAL	Water Strata	From	To	Thick-ness
Alluvium		0	1.5	1.5
Tuff welded		1.5	18.5	17'
Red Sandy Clay		18.5	27	8.5
Tuff, Red		27	45	18
Tuff, gray		45	65	20

Date Started 10/16 2002
Date completed 10/16 2002

7. WELL TEST DATA
Test Method: ☐ Bailer XPump ☐ Air Lift

	G.P.M.	Draw down (Feet Below static)	Time Hours)
			1 hour

8. WELL CONSTRUCTION
Depth Drilled 65 Feet Depth Cased ______ Feet

HOLE DIAMETER (BIT SIZE)

	From	To
6 Inches	0 Feet	65 Feet
Inches	Feet	Feet
Inches	Feet	Feet

CASING SCHEDULE

Size O.D. (inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (feet)	To (feet)
2		SCH 40	0	65

Perforations:
Type perforation Factory
Size perforation 20 -Slot
From 45 feed to 65 feet
From ______ feet to ______ fee
From ______ feet to ______ fe
From ______ feet to ______ fe
From ______ feet to ______ fe

Surface Seal: XYes ☐ No
Depth of Seal 31'
Placement Method. ☐ Pumped
X Poured

Seal Type
☐ Neat Cement
X Cement Grout
☐ Concrete Grout

Gravel Packed: X Yes ☐ No
From 31 feet to 65 feet

9. WATER LEVEL
Static water level 55' feet below land surface
Artesian flow ______ G.P.M ______ P.S.I.
Water temperature 64 °F Quality Clear

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name PC Exploration
Address 3883 Cincinnati Ave.
Rocklin, CA 95765-1302

Nevada contractor's license number issued by the State Contractor's Board 28767
Nevada driller's license number issued by the Division of Water Resources, the on-site driller M-2223
Signed [signature]
By driller performing actual drilling on site or contractor
Date 3-3-03

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STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

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OFFICE USE ONLY
Log No ____
Permit No ____
Basin ____

NOTICE OF INTENT NO 48196

1.OWNER Bureau of Land Management ADDRESS AT WELL LOCATION PERRY CANYON

MAILING ADDRESS 5665 Morgan Mill Rd Carson City NV 89701 . 2.

LOCATION SW 1/4 NW 1/4Sec 23 T 23 N/S R 21 E County WASHOE

PERMIT NO. ____ (Issued by Water Resources) ____ (Parcel No.) ____ (Subdivision Name)

3. WORK PERFORMED
X New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Abandon ☐ Other ____

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test ☐ Municipal/Industrial X Monitor ☐ Stock

5. WELL TYPE
☐ Cable X AirRotary ☐ Rvc X Air ☐ Other ....

6. LITHOLOGIC LOG

MATERIAL	Water Strata	From	To	Thick-ness
Alluvium		0	28	28
Red Clay		28	35	7'
Tuff		35	45	10
Red Clay		45	47	2
Volcanic Ash		47	55	8

Date Started 10/16 2002
Date completed 10/17 2002

7. WELL TEST DATA
Test Method: ☐ Bailer XPump ☐ Air Lift

	G.P.M.	Draw down (Feet Below static)	Time Hours)
			1 hour

8. WELL CONSTRUCTION
Depth Drilled 55 Feet Depth Cased 50 Feet

HOLE DIAMETER (BIT SIZE)

	From	To
6 Inches	0 Feet	50 Feet
Inches	Feet	Feet
Inches	Feet	Feet

CASING SCHEDULE

Size O.D. (inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (feet)	To (feet)
2		SCH 40	0	50

Perforations:
Type perforation Factory
Size perforation 20 -Slot
From 20 feed to 40 feet
From ____ feet to ____ feet
From ____ feet to ____ feet
From ____ feet to ____ feet
From ____ feet to ____ feet

Surface Seal: XYes ☐ No
Depth of Seal 15'
Placement Method: ☐ Pumped X Poured
Seal Type ☐ Neat Cement X Cement Grout ☐ Concrete Grout

Gravel Packed: X Yes ☐ No
From 15 feet to 50 feet

9. WATER LEVEL
Static water level 35' feet below land surface
Artesian flow ____ G.P.M ____ P.S.I.
Water temperature 64 °F Quality Turbid

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name PC Exploration
Address 3883 Cincinnati Ave.
Rocklin, CA 95765-1302

Nevada contractor's license number issued by the State Contractor's Board 28767
Nevada driller's license number issued by the Division of Water Resources, the on-site driller M-2223
Signed [signature]
By driller performing actual drilling on site or contractor
Date 3-3-03

(0)-627 .01POv

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DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

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Permit No ______
Basin ______

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NOTICE OF INTENT NO 48197

1.OWNER Bureau of Land Management ADDRESS AT WELL LOCATION PERRY CANYON
MAILING ADDRESS 5665 Morgan Mill Rd Carson City NV 89701 2.
LOCATION SE 1/4 SE 1/4Sec 15 T 23 N/S R 21 E County WASHOE
PERMIT NO. ______ (Issued by Water Resources) ______ (Parcel No.) ______ (Subdivision Name)

3. WORK PERFORMED
X New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Abandon ☐ Other ______

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test ☐ Municipal/Industrial X Monitor ☐ Stock

5. WELL TYPE
☐ Cable X Rotary ☐ Rvc X Air ☐ Other ....

6. LITHOLOGIC LOG

MATERIAL	Water Strata	From	To	Thick-ness
Rhyolite Tuff		0	40	40
FracturedTuff		40	62	22

Date Started 10/18 2002
Date completed 10/18 2002

7. WELL TEST DATA
Test Method: ☐ Bailer XPump ☐ Air Lift

	G.P.M.	Draw down (Feet Below static)	Time Hours)
			1 hour

8. WELL CONSTRUCTION
Depth Drilled 62 Feet Depth Cased 62 Feet
HOLE DIAMETER (BIT SIZE)
From To
6 Inches 0 Feet 62 Feet
______ Inches ______ Feet ______ Feet
______ Inches ______ Feet ______ Feet

CASING SCHEDULE

Size O.D. (inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (feet)	To (feet)
2		SCH 40	0	62

Perforations:
Type perforation Factory
Size perforation 20 -Slot
From 11 feed to 20 feet
From ______ feet to ______ fee
From 41 feet to 51 fe
From ______ feet to ______ fe
From ______ feet to ______ fe

Surface Seal: XYes ☐ No
Seal Type
Depth of Seal 11'
☐ Neat Cement
Placement Method: ☐ Pumped X Poured
X Cement Grout
☐ Concrete Grout

Gravel Packed: X Yes ☐ No
From 10 feet to 62 feet

9. WATER LEVEL
Static water level 17' feet below land surface
Artesian flow ______ G.P.M ______ P.S.I.
Water temperature 64 °F Quality Clear

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name PC Exploration
Address 3883 Cincinnati Ave.
Rocklin, CA 95765-1302

Nevada contractor's license number issued by the State Contractor's Board 28767
Nevada driller's license number issued by the Division of Water Resources, the on-site driller M-2223
Signed [signature]
By driller performing actual drilling on site or contractor
Date 3-3-03

(0)-627 .01POv

(Rev. 12-01)

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DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

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Basin ______

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NOTICE OF INTENT NO 48198

1.OWNER Bureau of Land Management ADDRESS AT WELL LOCATION PERRY CANYON
MAILING ADDRESS 5665 Morgan Mill Rd Carson City NV 89701 . 2.
LOCATION NW 1/4 SE 1/4Sec 15 T 23 N/S R 21 E County WASHOE
PERMIT NO. ______ ______ ______
Issued by Water Resources Parcel No. Subdivision Name

3. WORK PERFORMED
X New Well ☐ Replace ☐Recondition ☐Deepen ☐ Abandon ☐Other ______

4. PROPOSED USE
☐Domestic ☐Irrigation ☐Test ☐Municipal/Industrial X Monitor ☐ Stock

5. WELL TYPE
☐Cable X Rotary ☐Rvc X Air ☐ Other ....

6. LITHOLOGIC LOG

MATERIAL	Water Strata	From	To	Thick-ness
Alluvium		0	37	37
Tuff		37	40	3'

Date Started 10/19 2002
Date completed 10/19 2002

7. WELL TEST DATA
Test Method: ☐ Bailer XPump ☐ Air Lift

	G.P.M.	Draw down (Feet Below static)	Time Hours)
			1 hour

8. WELL CONSTRUCTION
Depth Drilled 40 Feet Depth Cased 35 Feet

HOLE DIAMETER (BIT SIZE)
From To
2 Inches 0 Feet 35 Feet
______ Inches ______ Feet ______ Feet
______ Inches ______ Feet ______ Feet

CASING SCHEDULE

Size O.D. (inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (feet)	To (feet)
2		SCH 40	0	50

Perforations:
Type perforation Factory
Size perforation 20 -Slot
From 20 feed to 35 feet
From ______ feet to ______ feet
From ______ feet to ______ feet
From ______ feet to ______ feet
From ______ feet to ______ feet

Surface Seal: XYes ☐ No
Depth of Seal 17'
Placement Method: ☐Pumped X Poured

Seal Type
☐ Neat Cement
X Cement Grout
☐ Concrete Grout

Gravel Packed: X Yes ☐ No
From 17 feet to 35 feet

9. WATER LEVEL
Static water level 21' feet below land surface
Artesian flow ______ G.P.M ______ P.S.I.
Water temperature 64 °F Quality Clear

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name PC Exploration
Address 3883 Cincinnati Ave.
Rocklin, CA 95765-1302

Nevada contractor's license number issued by the State Contractor's Board 28767
Nevada driller's license number issued by the Division of Water Resources, the on-site driller M-2223
Signed ______
By driller performing actual drilling on site or contractor
Date 3-3-03

(0)-627 .01POv

(Rev. 12-01) USE ADDITIONAL SHEETS IF NECESSARY